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HARVESTING EQUITY PREMIUM IN EMERGING MARKETS: A CURRENCY HEDGE FOR COUNTRY RISK

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Área de concentração:
Engenharia Financeira.

Orientador:
Alessandro Martim Marques

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ABSTRACT

We propose a consistent long equities long dollar framework for investing in emerging market equities. Economic theory suggests that both stocks (equity premium) and currencies (PPP in high inflation markets) should yield positive long-term returns. Furthermore, we show that observed inverse correlations between equities and foreign exchange derive mostly from country risk. A long equities long dollar strategy may therefore hedge out country risk and, crucially, still provide robust long-term returns. We study a 50% long equity 50% long dollar portfolio, rebalanced quarterly. Our framework has superior risk-adjusted returns in six of seven emerging markets we study, delivering risk-reward ratios that are 0.38 greater than local stock indices, on average; a statistically significant result at the 5% level. Our strategy also significantly reduces tail-risk loss by about 60%. We perform a portfolio optimization exercise that suggests a 70% long equity 30% long dollar optimal asset allocation for Sharpe ratio maximization and 40/60% for risk-reward optimization, on average. Finally, we show that our framework adds more value in situations where country risk is more prevalent.

Keywords: Portfolio optimization, equity premium, purchasing power parity, country risk, currency risk.

RESUMO

Propomos uma estratégia consistentemente comprada em índice de bolsa e comprada em dólar para investir em ações em mercados emergentes. A teoria econômica sugere que tanto as ações (prêmio de risco) quanto as moedas (PPC em mercados com alta inflação) devem render retornos positivos de longo prazo. Além disso, mostramos que a correlação inversa observada entre ações e moedas locais deriva-se principalmente do risco país. Uma estratégia comprada em ações e comprada em dólar pode, portanto, neutralizar o risco país e, o que é crucial, ainda fornecer retornos robustos de longo prazo. Estudamos um portfólio 50% comprado em ações 50% comprado em dólar, rebalanceado trimestralmente. Nossa estratégia tem retornos ajustados ao risco superiores em seis dos sete mercados emergentes que estudamos, entregando estatísticas de risco-recompensa que são 0,38 maiores do que os índices de ações locais, em média; um resultado estatisticamente significativo a um nível de confiança de 5%. Nossa estratégia também reduz perdas de cauda em cerca de 60%. Realizamos um exercício de otimização de portfólio que sugere uma alocação ótima de ativos de 70% bolsa 30% dólar para a maximização do índice de Sharpe e 40/60% para otimização de risco-recompensa, em média. Por fim, mostramos que nossa estrutura agrega mais valor em situações onde o risco país é mais prevalente.

Palavras-chave: Otimização de portfólio, prêmio de risco, paridade de poder de compra, risco país, risco moeda.

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1 INTRODUCTION

Investing in emerging equity markets (EEM) is risky business. EEM investors are exposed not only to traditional equity risk factors but also to a high degree of country risk in the way of political economic uncertainty. Volatility of equity returns in developing markets is much larger than in developed countries, and for foreign investors in particular the added currency risk is also a concern. The main purpose of this dissertation is to propose a simple yet economically sound and financially attractive investment strategy for EEM investors to harvest long-term equity returns while simultaneously hedging out both country and currency risk. Notably, we attempt to distinguish our work from traditional portfolio optimization literature by delving into the economic drivers of our proposed framework: why it should hold in the long-run.

Two fundamental pillars underlie our study. First, we investigate the relationship between currencies and stocks in emerging markets. We find that, after controlling for country risk and expanding the time horizon, the relationship between foreign exchange and equities is statistically insignificant. Second, we draw upon financial and economic literature, both of which suggest that equities and emerging market currencies should appreciate/devalue in the long-run. We stand on these two pillars to recommend a long equities long dollar investment strategy. The strategy provides significant risk reduction and, crucially, does not compromise long-term equity-like returns. On one hand, investors should be well-rewarded in the long-run by the equity risk premium. On the other hand, the long dollar position aptly hedges country risk while still offering the potential for long-term gains through economic equilibrium models such as purchasing power parity (PPP). Naturally, this combination also provides currency risk protection; investors are able to get the best of both worlds.

Our work resembles the research of Glen & Jorion (1993) and Campbell, Medeiros & Viceira (2010), both of which investigate the potential risk-minimizing benefits of adding safe-haven currencies to global portfolios. Yet we distinguish ourselves in a couple of ways. First and most importantly, we delve into the economic drivers behind our proposed strategy, allowing us to have more confidence that the conclusions we draw may hold in the long run. Second, we target emerging rather than developed markets. Specifically, we focus our attention on seven countries: Brazil, Chile, Colombia, Mexico, Russia, South Africa and Turkey.

Our dissertation also builds on the literature studying the relationship between local stocks and currencies. Although this subject is of great relevance for practitioners,

it has received relatively little academic attention. Hau & Rey (2006) develop a general equilibrium model in which local stock market relative out-performance leads to local currency depreciation as a result of incomplete foreign exchange hedging. Following a stock market relative gain foreign investors wishing to reduce increased currency exposure would sell local stocks and repatriate, buying foreign currency in the process. In turn, this would lead to local currency depreciation. A diverse body of literature has both reinforced (Curcuru et al. (2014)) and challenged (Cho et al. (2016), Aftab, Ahmad & Ismail (2018), Fuertes, Phylaktis & Yan (2019)) Hau & Rey's work. Consensus on the matter is lacking overall.

The purpose of this dissertation is not to develop a general equilibrium model to explain the relationship between stocks and currencies. Rather, we focus on one important common driver of stocks and currencies in emerging markets: country risk. One important contribution of this study is that it shows that the relationship between foreign exchange and equities in emerging markets is closely tied to country risk. After controlling for country risk, we find that the relationship is far more tenuous. This finding is essential for the strategy we propose because it means that purchasing dollars should not meaningfully detract from the long-term equity premium investors wish to harvest out of emerging market stocks. The dollar-end of the strategy will not only protect investors from potentially burdensome country and currency risk but also may provide a long-term return in of itself through the predictions of economic equilibrium models such as PPP.

Another key contribution of this study is that it suggests that coupling local equities with dollars is attractive for domestic and foreign investors alike. Thus far, the literature on this topic has largely focused on foreign exchange risk from the point of view of foreign investors. The results of our dissertation suggest that the protection from country risk given by owning dollars is attractive for domestic investors as well. We provide statistical, economic and financial evidence in favor of our proposed strategy. As such, it is relevant both from an academic and from a practitioner's standpoint.

The remainder of this work is organized as follows. Chapter 2 provides a literature review of the various strands of research related to our topic of concern. Chapter 3 describes our data sources and variables of interest. Chapter 4 analyzes the relationship between local stocks and currencies for our countries of interest. Chapter 5 builds the historical total return of our strategy and investigates its financial characteristics, both absolutely and relative to alternatives. Chapter 6 explores under what circumstances our framework adds more value. Chapter 7 investigates the optimal hedge ratio of our proposed strategy. A final chapter concludes.

2 LITERATURE REVIEW

Our work draws upon two main strands of literature. The first relates to portfolio risk management and the second more broadly studies the relationship between currencies and stocks. We review relevant works in these fields in order, starting with the portfolio risk management literature. We also briefly review literature on the equity risk premium and on purchasing power parity, as they provide the economic fundamentals that underlie our proposed strategy.

The international asset-pricing model (IAPM) of Solnik (1974) outlines a mean-variance optimization framework for international investing, whereby investors hold a combination of the domestic risk-free rate and a portfolio of world assets, including stocks and bills. One result of this model is that all investors should optimally hedge the same portfolio of risky assets against currency risk. The amount of hedging depends on the risk tolerance of each investor and on the correlation between exchange rates and assets.

Black (1989) builds on the IAPM framework. Adding additional assumptions he deduces an optimal hedge ratio for global investors exposed to currency risk. Black's framework results in a derived optimal hedge ratio that is close to but a bit below one. In other words, the optimal strategy is to hedge some but not all of the currency risk when investing internationally. The work is purely theoretical.

Subsequent work by Glen & Jorion (1993) empirically investigates the issue of currency hedging bond and stock portfolios by looking at returns data between 1974 and 1990 for the United States, Germany, Japan, United Kingdom and France. They find that unconditional currency hedging results in statistically significant improvements in risk-adjusted performance for bond but not stock portfolios. However, when hedging over a pre-determined bond or stock portfolio they find no substantial risk-adjusted performance benefit of currency hedging. Notably, they do document that currency hedging substantially reduces the risk of international investments, as measured by the standard deviation of returns.

Walker (2008) reverses the currency hedging problem: should an investor located in emerging markets hedge currency risk when investing in developed markets? For example, should a Brazilian-based investment firm hedge currency risk when investing in the S&P 500 index? He finds that no. Since (in our example) the Brazilian real has a positive correlation with global risk, hedging currency risk in this case increases portfolio volatility, although also increasing expected returns.

Campbell, Medeiros & Viceira (2010) study the relationship between equities and currencies in seven developed economies: Australia, Canada, "Euroland", Japan, Switzerland, the United Kingdom and the United States.[1] They look at data from 1975 to 2005 and, in contrast to Glen & Jorion (1993), find that risk-minimizing global equity investors should seek to couple their equity investments with safe-haven currencies such as the U.S. dollar, the euro and the Swiss franc. These currencies have observed negative correlations with global stock market movements and are therefore attractive from a risk-minimizing perspective. They show, for example, that a risk-minimizing U.S. equity manager investing abroad should at least fully hedge and maybe even over-hedge. Their research also challenges the proposition of a universal hedge ratio: the optimal hedge ratio depends on the specific stock market and currency.

Kim (2012) builds on the aforementioned literature and brings the question to emerging markets, asking whether currency hedging is necessary for emerging market equity investment. In contrast with our analysis, they find that when a developed market investor buys emerging market stocks no currency hedging is necessary. In fact, they document that no currency hedging is actually superior to full currency hedging. They analyze eleven emerging market countries between 2001 and 2010 and compare Sharpe ratios from hedged and unhedged portfolios to reach their conclusion. We note that this was an uncharacteristically very benign decade for emerging markets in general.

We distinguish ourselves from previous portfolio management literature on this topic in two key ways. For one thing, we delve into the economic rationale behind our strategy: why it should hold in the long-run. For another, we tackle the point of view not from the perspective of hedging currency risk but from the perspective of tackling country risk. This means that our propositions are relevant not only from the perspective of foreign investors but also from the viewpoint of domestic investors. This is a major shift from traditional literature, which has always framed the issue from a home-foreign perspective. Our conclusions apply to both domestic and foreign emerging market equity investors.

We now turn to the literature on the relationship between stocks and currencies. Hau & Rey (2006) develop a general equilibrium model in which local stock market outperformance leads to local currency depreciation as a result of incomplete foreign exchange hedging. They term their framework Uncovered Equity Parity (UEP). Following a stock market relative gain foreign investors wishing to reduce added currency exposure would sell local stocks and repatriate, buying foreign currency in the process. In turn, this would lead to local currency depreciation. They support their model with evidence from seventeen OECD countries. Their data shows that foreign stock market over-performance correlates

[1] "Euroland" is defined as a value-weighted stock basket that includes Germany, France, Italy and the Netherlands.

with exchange rate depreciation in a statistically significant way and that portfolio outflows correlate with exchange rate depreciation.

Curcuru et al. (2014) provide further partial support for the UEP framework. They find that equity flows are contemporaneously positively correlated with currency movements and that indeed investors sell foreign equity markets that recently out-performed. Interestingly, they find this latter behavior to be asymmetric: investors do not increase flows into stock markets that have recently under-performed. Most importantly, however, they challenge the mechanism proposed in UEP; investors do not sell out-performers to reduce added currency risk. Instead, they find that equity rebalancing is more related to the performance of equity markets than currency markets, and that therefore these reallocations are driven due to positioning to earn higher expected returns rather than to mitigate risk.

Cho et al. (2016) investigate the predictions of UEP for a set of nine developed and eleven developing economies. In accordance with Hau & Rey (2006) they confirm a weakly negative correlation between currencies and equities in the developed world. In the emerging market world, however, they observe the opposite: there is a positive correlation between local equities and currencies. They attribute this finding to a flight-to-quality effect. In global up-trending markets capital tends to move into developing countries, generating both a positive currency and equity return. In global down-trending markets capital tends to move out of developing and into developed countries, generating a negative correlation between currency and equity return in developed markets.

Aftab, Ahmad & Ismail (2018) study the relationship between equities and currencies in six Asian markets (Indonesia, South Korea, Malaysia, Philippines, Singapore and Thailand). Their findings corroborate Cho et al. (2016) in that there appears to be a positive correlation between stocks and currencies in developing markets, in contrast to what would be expected by the UEP framework. Fuertes, Phylaktis & Yan (2019) document the same thing in eight Asian economies. They attribute the failure of UEP in their data set to investors' return-chasing behavior.

More recently, Jung & Jung (2021) studied eighteen Asian economies and also found evidence contradicting the negative stock-currency correlation proposed by UEP. Most interestingly, however, they show that reversal from UEP becomes stronger with stock market uncertainty, as measured by equity volatility. This proposition relates directly to our topic of study: the role country risk plays in the relationship between currencies and stocks in emerging markets. Although the authors do not address the issue in this specific framework, stock market uncertainty is after all a measure of risk, including country risk.

To our knowledge, and albeit indirectly, Jung & Jung (2021) are the first to hint at what our work will explore in detail further on.

We now briefly review the literature on the equity premium and purchasing power parity, which together form the economic bedrock behind our proposed framework.

The equity premium is defined as the return rate of stocks in excess of a risk-free rate. Mehra & Prescott (1985) calculated that between 1889-1978 the equity premium of US stocks stood above 6% per year. The paper was seminal because the high observed equity premium could not be reasonably explained in the framework of standard general equilibrium models which, calibrated to the US cycle, generated an equity premium of less than 1%. Mehra and Prescott coined this inconsistency as the equity premium puzzle.

Siegel (1992) documented a real average annualized equity return of 5.7%, 6.6% and 6.4% over the sub-periods 1802-70, 1871-1925 and 1926-90, respectively. Over these same sub-periods the return on short-term government bonds was 5.1%, 3.1% and 0.5%. This would imply an average equity premium of 3.3% over the entire period but which has increased substantially over the years.

Fama & French (2002) attemped to calculate the *ex-ante* equity premium in two different ways: a dividend and an earnings growth model. The first one produced an ex-ante estimate of 2.55% for the period 1951 to 2000 while the second one produced an ex-ante estimate of 4.32%. The actual observed annual premium during this time period was 7.43%. Fama and French attribute the sub-estimate of their model to a falling discount rate over time, which produce large capital gains in shorter time frames.

Salomons & Grootveld (2003) extend the equity premium analysis to 24 emerging markets. They found that, on average, emerging markets have an equity premium that is around 6% higher than developed markets per year. Naturally, the higher equity premium in emerging markets comes at the cost of markedly higher downside risks, with equity premium return distributions exhibiting significantly higher kurtosis in emerging markets than in developed markets. Notably, their analysis compares US dollar returns with US dollar risk-free rates. The analysis is therefore relevant from the perspective of a foreign US investor rather than from the perspective of local investors in each of these countries.

Overall, the literature on the equity premium is vast and mostly conclusive: over the (sometimes very long) term, equities reward investors with a premium over a risk-free rate.

Last but not least, we turn to exchange rates. The most popular and well-studied economic theory about long-term determinants of the exchange rate is purchasing power

parity. Absolute purchasing power parity states that exchange rates should value or devalue to adjust to price level differentials between basket of goods in different countries. Relative purchasing power parity focuses only inflation rate differences: exchange rates should value or devalue according to the inflation differential between countries. Broad price level differences may be explained by more permanent structural differences (i.e. transport and transactions costs or tariffs), and therefore relative purchasing power parity focuses only on exchange rate trends as compared to inflation rate differentials.

The literature on PPP has evolved significantly over the many decades it has been studied. Early work on PPP in the 70's and 80's found little empirical support for the theory. Authors could not reject the hypothesis that the real exchange rate followed a random walk, which is inconsistent with PPP mean-reversion (Roll (1979), Adler & Lehmann (1983), Taylor (1988), Mark (1990)). Although initially discouraging for the PPP hypothesis, subsequent literature would point out that the tests employed in earlier papers lacked statistical power. As more data were collected and more powerful statistical tests idealized, long-run evidence for PPP started to become clearer (Rogoff (1996), Taylor (2002)). The current standing of literature is that PPP holds in the very long-run, but does not explain short- or medium-term market fluctuations. Indeed, convergence to PPP has been to show take several years. The half-life of PPP has been estimated at about five years, on average. Interestingly, a recent study has posited that this half-life may have decreased over the years to about three years Rabe & Waddle (2020).

Our dissertation builds on all of the literature above to propose a simple yet effective long equities long dollar investment strategy for EEM investors. Long-run returns will be driven by a combination of the equity premium and PPP, while the relationship between currencies and stocks in emerging markets will result in a portfolio that is hedged from country and currency risk, thereby greatly reducing risk. These issues will be explored in detail in the next chapters.

3 DATA DESCRIPTION

Our empirical analysis focuses on seven emerging market stock indices: IBOVESPA (Brazil), MEXBOL (Mexico), IPSA (Chile), XU100 (Turkey), COLCAP (Colombia), MOEX (Russia) and JALSH (South Africa). The US dollar is the chosen safe-haven currency; it has been shown to have negative correlation with global stock markets (*e.g.* Campbell, Medeiros & Viceira (2010)). We use total stock and foreign exchange returns, thereby accounting for reinvested dividends and interest rate yields. Our work considers data beginning from about 2000 to the end of 2020, although this varies slightly for each specific country. We extract our data using the Bloomberg Terminal. Appendix A shows the Bloomberg tickers for our data, as well as the initial data range for each country. Unless otherwise stated, analyses are run from this initial data range to the end of 2020.

One of the central focuses of our study is on how country risk affects the relationship between currencies and stocks in emerging markets. Accordingly, we must select a market proxy for country risk. We selected the JP Morgan EMBI+ spread. This spread is the difference between the weighted average of external debt securities yields and US Treasury security yields with similar maturity. Notably, the EMBI+ index does not exist for Chile. As a result, for Chile specifically we use the five-year sovereign CDS spread.[2] The correlation between the EMBI+ and the CDS is high and ensuing results using either of them are similar. We chose to work with the EMBI+ because a total return series was readily available and because data for earlier periods are more complete. To construct a total return series for the EMBI+ spread we strip the treasury return from the EMBI+ index, which includes both the spread and the underlying treasury return. To do so we use the ten year treasury total return. Although the duration of the EMBI+ indices vary and are not exactly that of the ten year treasury, these differences do not significantly alter results.

Table 1, shows weekly and quarterly correlations between stocks, foreign exchange and the EMBI+ spread percentage changes for each country. Importantly, in this dissertation a negative currency return signals local currency appreciation. Table 1 shows that the correlation between equities and FX is strongly negative: when stock markets perform well the associated currency tends to appreciate. The relationship between FX and EMBI+ spreads is positive: when spreads widen local currencies devalue. Finally, the correlation between equities and EMBI+ spreads is negative: when spreads widen the stock market falls. Chiefly, we note that the correlation between EMBI+ spreads and the stock market is stronger than between stocks and currencies for all emerging markets studied.

[2]From here on we always refer to the country risk variable as being the EMBI+, but stress that in the Chilean case this actually refers to the five-year CDS.

Table 1 – Cross-asset Pearson correlation coefficients

	EQUITIES - FX		**FX - EMBI+ SPREAD**		**EMBI+ SPREAD - EQUITIES**	
	WEEKLY	QUARTERLY	WEEKLY	QUARTERLY	WEEKLY	QUARTERLY
BRAZIL	-0.57	-0.70	0.62	0.77	-0.68	-0.77
MEXICO	-0.46	-0.57	0.62	0.76	-0.57	-0.75
SOUTH AFRICA	-0.22	-0.38	0.51	0.77	-0.44	-0.63
TURKEY	-0.54	-0.54	0.61	0.59	-0.63	-0.80
CHILE	-0.29	-0.50	0.39	0.49	-0.45	-0.71
COLOMBIA	-0.41	-0.59	0.55	0.65	-0.50	-0.70
RUSSIA	-0.23	-0.29	0.47	0.59	-0.58	-0.73

1. Weekly percentage changes are calculated using the average quote for a given week against the previous week. Quarterly percentage changes consider the average of the last week of each quarter.

Table 2 shows descriptive return statistics of our time series. A couple of takeaways are worth noting. First, stock Sharpe ratios are quite low across the board. These low Sharpe ratios are a result of two factors: (1) high interest rates and (2) high volatility. In fact, in Brazil and Turkey excess returns are negligible and even negative for Brazil's IBOVESPA. Second and most importantly, stock and foreign exchange absolute returns are both positive over the twenty-year period of this study. Yet these two variables have a negative correlation, as observed from Table 1. This characteristic hints that a long equities long dollar strategy could provide positive long-term returns with relevant risk-reduction. Indeed, this idea is the core of the strategy we propose in subsequent chapters.

Table 2 – Total return summary statistics

	BRAZIL	MEXICO	SOUTH AFRICA	TURKEY	CHILE	COLOMBIA	RUSSIA
Interest Rate Return	11.71	6.47	7.08	14.52	3.39	5.36	6.39
Stock Total Return - - -	9.38	10.59	12.20	15.03	7.73	14.85	16.87
Stock Volatility	28.99	20.39	19.46	28.38	16.87	20.63	31.04
Stock Excess Return	-2.33	4.11	5.12	0.51	4.34	9.49	10.48
Stock Risk-Reward	0.32	0.52	0.63	0.53	0.46	0.72	0.54
Stock Sharpe	-0.08	0.20	0.26	0.02	0.26	0.46	0.34
FX Total Return - - -	7.07	5.58	3.43	10.40	1.45	3.41	6.75
FX Volatility	17.18	11.85	17.97	15.29	10.46	12.25	13.09
FX Excess Return	-4.64	-0.89	-3.65	-4.12	-1.94	-1.95	0.36
FX Risk-Reward	0.41	0.47	0.19	0.68	0.14	0.28	0.52
FX Sharpe	-0.27	-0.08	-0.20	-0.27	-0.19	-0.16	0.03
EMBI+ Total Return - - -	9.90	8.37	6.65	8.73		8.78	10.66
EMBI+ Volatility	12.17	8.36	7.23	10.96		8.98	9.43
EMBI+ Excess Return	-1.81	1.89	-0.43	-5.79		3.42	4.26
EMBI+ Risk-Reward	0.81	1.00	0.92	0.80		0.98	1.13
EMBI+ Sharpe	-0.15	0.23	-0.06	-0.53		0.38	0.45
EMBI+ Spread Total Return - - -	4.46	2.93	1.61	3.68		3.93	5.41
EMBI+ Spread Volatility	13.89	9.98	9.94	13.48		11.09	12.00
EMBI+ Spread Excess Return	-7.24	-3.54	-5.47	-10.84		-1.43	-0.98
EMBI+ Spread Risk-Reward	0.32	0.29	0.16	0.27		0.35	0.45
EMBI+ Spread Sharpe	-0.52	-0.35	-0.55	-0.80		-0.13	-0.08

1. Statistics are annualized from the daily geometric mean and standard deviation.

4 STOCKS, CURRENCIES AND COUNTRY RISK

In the previous chapter we calculated correlation coefficients between our variables of interest. Table 1 showed that the relationship between stocks and foreign exchange is strong and negative. The literature we reviewed shows that for emerging markets this is generally the case empirically, even though the UEP framework suggests otherwise. Yet if we look at the figures in Appendix A we can spot out several periods when stocks and currencies observed a positively correlated underlying trend. In fact, for several emerging market companies, a devalued currency gives a significant boost to export-heavy earnings. Moreover, as Table 2 showed, both stocks and foreign exchange have provided long-term positive total returns. Where then, does the estimated negative relationship between stock prices and exchange rates come from? We hypothesize the answer lies in country risk.

Country risk is a key common risk factor for stocks and currencies in emerging markets. We use multivariate regression analysis to begin investigating our hypothesis. We regress weekly stock market percentage returns on (1) foreign exchange percentage returns and (2) on the percentage change of the EMBI+ spread, as per equation 4.1.

$$Stock_{\%\delta t} = \alpha_1 + \beta_1 FX_{\%\delta t} + \beta_2 EMBI_{\%\delta t} + \varepsilon_t \tag{4.1}$$

Subsequently, we gradually decrease the frequency of the regression up to semi-annually (which is as far as we can go without significantly compromising the number of observations). The idea behind decreasing the frequency of our regression is to gauge at what happens as we move from a shorter- to a longer-term relation. Table 3 shows the t-statistic of the FX and EMBI+ spread beta coefficients for the regressions run on different frequencies. As we decrease the frequency the significance of the FX beta drops greatly. For the semi-annual frequency, six out of seven FX return beta estimates are insignificant at the 5% level, just barely making the cut in the case of Chile. Remarkably, three of the seven countries even have positive foreign exchange beta estimates (Mexico, South Africa and Russia). In contrast, beta estimates for the EMBI+ spread are always negative and remain significant for all frequencies.

Table 3 – Multivariate regression beta t-statistics

	WEEK	MONTH	QUARTER	SEMESTER
BRAZIL FX	-8.52*	-2.95*	-2.40*	-0.48
MEXICO FX	-5.37*	-0.85	0.14	1.08
SOUTH AFRICA FX	0.12	1.79	1.90	0.76
TURKEY FX	-8.19*	-1.98	-1.30	-1.39
CHILE FX	-4.34*	0.37	-2.03	-2.09*
COLOMBIA FX	-5.89*	-2.51*	-2.02	-1.52
RUSSIA FX	1.80	1.65	1.85	1.00
BRAZIL EMBI+ Spread	-19.51*	-10.94*	-5.40*	-5.27*
MEXICO EMBI+ Spread	-14.92*	-9.73*	-6.75*	-5.03*
SOUTH AFRICA EMBI+ Spread	-13.17*	-7.94*	-5.92*	-3.01*
TURKEY EMBI+ Spread	-15.75*	-9.72*	-8.44*	-7.54*
CHILE EMBI+ Spread	-12.60*	-9.86*	-6.48*	-2.19*
COLOMBIA EMBI+ Spread	-11.90*	-7.03*	-5.12*	-2.09*
RUSSIA EMBI+ Spread	-19.52*	-11.31*	-7.88*	-6.01*

1. Model specification: $Stock_{\%\delta t} = \alpha_1 + \beta_1 FX_{\%\delta t} + \beta_2 EMBI_{\%\delta t} + \varepsilon_t$
2. Coefficients significant at the 5% level are marked with an asterisk (*).

The results of Table 3 suggest that as the frequency of the analysis diminishes (*i.e.* as we move gradually from a shorter- to a longer-term), and after controlling for the common country risk factor, the underlying relationship between stock and foreign exchange returns is more tenuous than what simple correlation analysis suggests. To press the issue further we alter our statistical test slightly. Rather than performing a regression of stock returns simultaneously against FX returns and EMBI+ spread percentage changes, we first fit stock returns to FX returns and then regress the residuals of this regression against the EMBI+ spread as portrayed in equations 4.2 and 4.3, and vice-versa.

$$Stock_{\%\delta t} = \alpha_1 + \beta_1 FX_{\%\delta t} + \varepsilon_t \tag{4.2}$$

$$\varepsilon_t = \alpha_2 + \beta_2 EMBI_{\%\delta t} + \eta_t \tag{4.3}$$

We focus on the quarterly and semi-annual cases as lower-frequency results are more interesting for the longer-term focus of our strategy. Tables 4 and 5 display the t-statistic for the β_2 coefficient in both setups of the residual regression.

The residual regression analysis validates the previous multivariate regressions. For all countries and for both quarterly and semi-annual frequencies, foreign exchange returns fitted on the residuals of a simple linear regression of stock returns against EMBI+ spread percentage changes are not statistically significant. In contrast, EMBI+ spreads

Table 4 – Quarterly residual regression beta t-statistics

	FX Residual, EMBI+ Beta	EMBI+ Residual, FX Beta
BRAZIL	-3.15*	-1.51
MEXICO	-3.83*	0.09
SOUTH AFRICA	-3.31*	1.19
TURKEY	-5.93*	-1.05
CHILE	-5.30*	-1.76
COLOMBIA	-3.62*	-1.52
RUSSIA	-5.70*	1.50

1. Model specification : First we estimate the model $Stock_{\%\delta t} = \alpha_1 + \beta_1 FX_{\%\delta t} + \varepsilon_t$. We then take the residual of this regression and estimate the model $\varepsilon_t = \alpha_2 + \beta_2 EMBI_{\%\delta t} + \eta_t$. The t-statistic for β_2 is the left-hand-column. The opposite process is also run and the ensuing t-statistic is displayed in the right-hand-column.
2. Coefficients significant at the 5% level are marked with an asterisk (*).

Table 5 – Semi-annual residual regression beta t-statistics

	FX Residual, EMBI+ Beta	EMBI+ Residual, FX Beta
BRAZIL	-2.86*	-0.31
MEXICO	-3.04*	0.75
SOUTH AFRICA	-2.16*	0.58
TURKEY	-4.91*	-1.13
CHILE	-1.61	-1.54
COLOMBIA	-1.46	-1.08
RUSSIA	-4.74*	0.87

1. Model specification : First we estimate the model $Stock_{\%\delta t} = \alpha_1 + \beta_1 FX_{\%\delta t} + \varepsilon_t$. We then take the residual of this regression and estimate the model $\varepsilon_t = \alpha_2 + \beta_2 EMBI_{\%\delta t} + \eta_t$. The t-statistic for β_2 is the left-hand-column. The opposite process is also run and the ensuing t-statistic is displayed in the right-hand-column.
2. Coefficients significant at the 5% level are marked with an asterisk (*).

predominantly maintain significance when fitted against the residuals of a stock-to-foreign-exchange return regression. This is true for all countries in the quarterly regressions and for five of seven countries in the semi-annual regression. Last, for all quarterly and semi-annual residual regressions, the t-statistic of the EMBI+ beta is more negative than the FX return beta.

To further test the consistency of our analysis we divide our sample period into two: one up to and including 2010 and another since 2011. Results from the ensuing quarterly and semi-annual multivariate regressions, as per equation 4.1, are displayed in Table 6. We draw to attention to the fact that semi-annual regressions in the reduced sample size have a smaller number of observations (around 20).

Table 6 – Multivariate regression t-statistics for different sub-periods

	2000 - 2010		**2011 - 2020**	
	QUARTER	SEMESTER	QUARTER	SEMESTER
BRAZIL FX	-2.92*	-0.51	0.49	0.96
MEXICO FX	-0.75	1.00	0.09	0.45
SOUTH AFRICA FX	1.52	0.53	1.79	1.38
TURKEY FX	-1.88	-0.53	0.03	-1.37
CHILE FX	-0.80	-0.05	-1.34	-2.60*
COLOMBIA FX	-1.27	-0.43	-1.55	-0.67
RUSSIA FX	1.01	1.26	1.43	1.62
BRAZIL EMBI+ Spread	-3.03*	-3.47*	-5.39*	-5.00*
MEXICO EMBI+ Spread	-5.08*	-3.43*	-4.39*	-4.19*
SOUTH AFRICA EMBI+ Spread	-3.67*	-1.45	-5.31*	-4.03*
TURKEY EMBI+ Spread	-5.12*	-6.11*	-5.71*	-4.04*
CHILE EMBI+ Spread	-5.23*	-3.03*	-4.31*	-1.05
COLOMBIA EMBI+ Spread	-4.05*	-1.26	-4.24*	-3.91*
RUSSIA EMBI+ Spread	-5.53*	-4.33*	-6.42*	-4.02*

1. Model specification: $Stock_{\%\delta t} = \alpha_1 + \beta_1 FX_{\%\delta t} + \beta_2 EMBI_{\%\delta t} + \varepsilon_t$
2. Coefficients significant at the 5% level are marked with an asterisk (*).

The results from the sub-period analysis supports previous evidence. For regressions in quarterly frequency, foreign exchange returns are insignificant in thirteen out of fourteen cases. For regressions in semi-annual frequencies, foreign exchange returns are insignificant also at thirteen out of fourteen cases. In contrast, EMBI+ spread percentage changes are significant in all quarterly regressions and in eleven of fourteen semi-annual regressions. These results provide evidence that FX returns do not significantly covariate with equity returns in a longer-term setting and after accounting for the covariation between stock returns and country risk. The observed negative relationship between FX and stock returns seems to be largely explained by their common country risk exposure.

The results of our economic analysis in this chapter, combined with the descriptive statistics of chapter 3 and with our literature review, suggests that a viable strategy to minimize country risk exposure without significantly compromising long-term returns could be to construct a long equities long dollar portfolio. Indeed, economic theory suggests that underlying absolute long-term returns for both equities (the equity premium) and currencies (purchasing power parity in high-inflation emerging market currencies) are positive. Furthermore, our regression analysis seems to suggest that the observed negative correlation between stocks and currencies derives largely from country risk. A long equities long dollar strategy could thus harvest structural long-term gains from both equities and the dollar while netting out the inverse relationship they have with country risk. We investigate the financial characteristics of such a strategy in the next chapter.

5 A CURRENCY HEDGE FOR COUNTRY RISK

Building on the results obtained thus far we construct a long equities long dollar investment portfolio. The reasoning behind our strategy is twofold. First, the relationships explored in chapter 4 will result in a portfolio that is hedged from short-term fluctuations deriving from country risk. Second, long-run returns will be driven by a combination of the equity premium and purchasing power parity. Indeed, we observed in chapter 3 that both equities and FX have positive absolute returns over our sample period. Therefore in this framework, the dollar serves as a non-costly hedge for country risk volatility. A long equities long dollar strategy would harvest structural long-term gains from both equities and the dollar while netting out the inverse relationship they have with country risk.

We construct our strategy as follows. Initial equity and dollar portfolio weights are set at w_{e_1} and w_{d_1}, respectively, where $w_{e_1} + w_{d_1} = 1$. No leverage is allowed. Given portfolio weights at time t and equity ($r_{e_{t+1}}$) and dollar ($r_{d_{t+1}}$) total returns at time $t+1$ the total return of the portfolio at time $t+1$ is given by:

$$r_{p_{t+1}} = r_{e_{t+1}} w_{e_t} + r_{d_{t+1}} w_{d_t}$$

Portfolio weights are subsequently given by

$$w_{e_{t+1}} = \frac{w_{e_t}(1 + r_{e_{t+1}})}{w_{e_t}(1 + r_{e_{t+1}}) + w_{d_t}(1 + r_{d_{t+1}})}$$

$$w_{d_{t+1}} = \frac{w_{d_t}(1 + r_{d_{t+1}})}{w_{e_t}(1 + r_{e_{t+1}}) + w_{d_t}(1 + r_{d_{t+1}})}$$

Every quarter-end portfolio weights are rebalanced such that $w_{e_t} = w_{e_1}$ and $w_{d_t} = w_{d_1}$. For the analysis in this chapter, we set initial equity and dollar weights to 50%. Notably, we choose 50% as our starting point because that would also fully hedge currency risk, but we explore the optimal ratio problem in chapter 7. We do not consider transaction costs in our analysis, but remark that the rebalancing frequency is low and that the markets we work with are quite liquid and have low transaction costs, such that their impact should be minor.

One question that arises immediately within our framework is the following: if the objective is to hedge country risk why not short the EMBI+ spread rather than buying dollars? According even to our own analysis, this would be a more direct protection against country risk. To address this issue we also build an identical strategy that is 50% invested in local stocks and 50% short the EMBI+ spread. We compare this approach to our proposed long equities long dollar framework. The *ex-ante* logic behind our preferred long dollar position is that it aptly hedges country risk and is less detrimental to long-term returns than a short EMBI+ spread position.

We now analyze the financial characteristics of our framework. Importantly, we draw attention to two points. First, all calculations are performed using the geometric mean and standard deviation. Second, Appendix B describes the column names and legends used in this chapter, chosen due to their brevity.

5.1 An initial analysis of Sharpe ratios

Almost every financial portfolio analysis begins with Sharpe ratios. We do the same. Table 7 shows the Sharpe ratios for our proposed strategy and for local stock indices. We divide our analysis into three periods: the full sample, 2000 to 2010 and 2011 to 2020.[3] Two things stand out in Table 7: (1) Sharpe ratios favor neither our framework nor local stock indices and (2) many Sharpe ratios are very small or even negative. Negative or minor excess returns are extremely undesirable; returns are not rewarding risk. The occurrence of small or even negative Sharpe ratios over several sample periods in the emerging markets we study begs the question of whether risk-taking is at all desirable in these markets. We do not tackle this extremely convoluted question in this dissertation. Rather, we simply posit that investors that plan on spending one unit of risk in emerging market stocks may consider hedging some of that risk using the US dollar.

Table 7 – Portfolio Sharpe ratios

	Full Sample		**2000 - 2010**		**2011 - 2020**	
	STOCKS/FX	STOCKS	STOCKS/FX	STOCKS	STOCKS/FX	STOCKS
BRAZIL	-0.10	-0.08	-0.33	-0.05	0.20	-0.13
MEXICO	0.27	0.20	0.44	0.40	0.02	-0.12
SOUTH AFRICA	0.14	0.26	-0.10	0.31	0.41	0.21
TURKEY	0.00	0.02	-0.42	-0.02	0.49	0.06
CHILE	0.24	0.26	0.66	0.96	-0.11	-0.29
COLOMBIA	0.56	0.46	1.01	1.05	0.07	-0.21
RUSSIA	0.48	0.34	0.55	0.42	0.40	0.22
AVERAGE	0.23	0.21	0.26	0.44	0.21	-0.04

1. Statistics are annualized from the daily geometric mean and standard deviation.

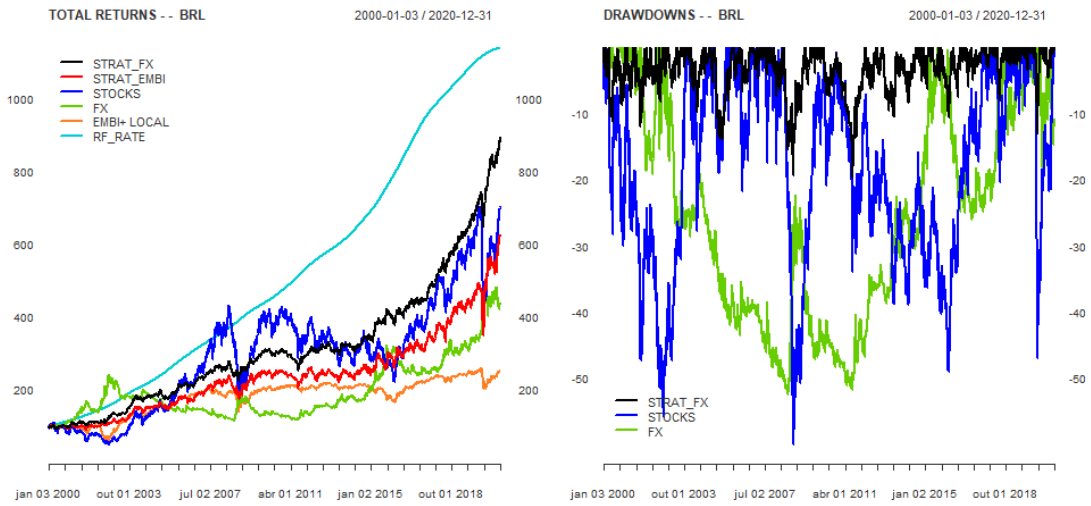
Beyond the more fundamental question of whether equity investing in emerging markets is at all desirable, the presence of low excess returns complicates comparison between our framework and local stock indices. When excess returns are low Sharpe ratios do not adequately discriminate between risk metrics. To give one extreme yet illustrative example, two strategies with zero excess return will have the same Sharpe ratio regardless of their volatility. To circumvent this problem we analyze each one of our countries individually and consider a whole host of distribution statistics. Doing so enables us to look into portfolio metrics in more detail and draw more interesting insights. Appendix B contains the mathematical definitions and economic interpretations of all metrics we analyze. Countries are analyzed in alphabetical order, beginning with Brazil.

[3] A few countries do not have reliable data until around 2002. In those cases the first sample period spans from 2002 to 2010.

5.2 Brazil

Detailed statistics of our proposed investment framework for Brazil are displayed below. In Appendix C we also display the graph of the varying portfolio weights for the long equities long dollar approach and for the long equities short EMBI+ spread alternative.

Figure 1 – Brazil portfolio time-series: full sample



(a) Returns (b) Drawdowns

Table 8 – Brazil portfolio statistics: full sample

	2000 - 2020		
	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	10.52	8.82	9.38
EXCESS RETURN	-1.19	-2.89	-2.33
VOLATILITY	12.10	17.38	28.99
BETA	0.32	0.50	1.00
RISK REWARD	0.87	0.51	0.32
SHARPE	-0.10	-0.17	-0.08
SORTINO	-0.09	-0.17	-0.08
TREYNOR	-3.74	-5.80	-2.33
CONDITIONAL 95% RR	6.41	3.93	2.32
CONDITIONAL 95% SHARPE	-0.72	-1.29	-0.58
SKEW	-0.11	1.88	-0.11
KURTOSIS	6.83	39.12	10.26
SHORTFALL 95%	-1.64	-2.24	-4.05
MAX DRAWDOWN	-19.73	-29.93	-59.96

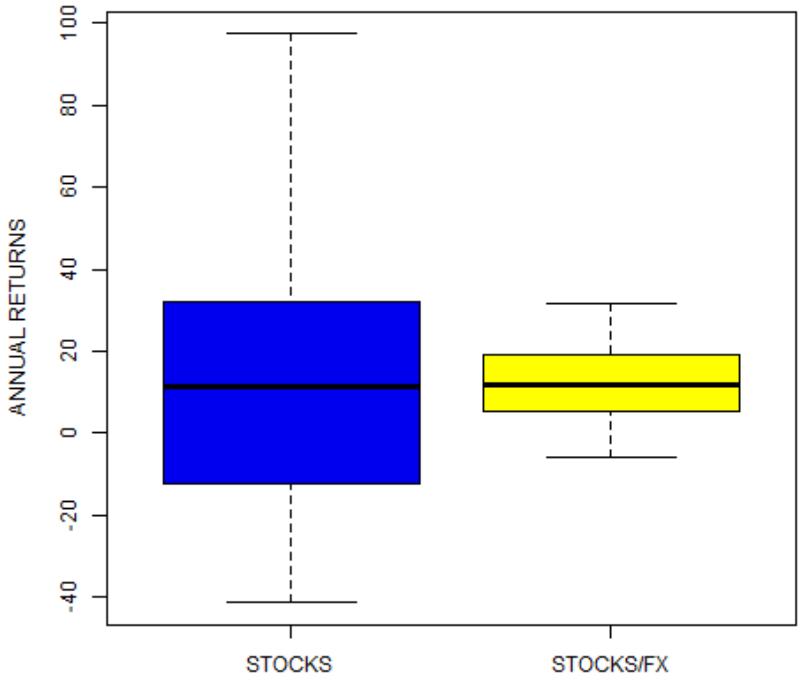
1. Statistics are annualized from the daily geometric mean and standard deviation.

Brazil is an interesting case. The best investment over the last two decades, by a milestone, has been the risk-free rate. Yet if we compare our investment approach to the IBOVESPA we see that it is able to offer a higher return with much less risk. The

volatility of our approach is less than half that of the IBOVESPA, as is the 95% expected shortfall and the maximum drawdown. We also remark that our long dollar long equities approach is preferred to the alternative long equities short EMBI+ spread on all metrics. Although the EMBI+ does offer risk reduction, the short EMBI+ spread position charges a higher toll on return than the long dollar position.

We draw a boxplot of the annual returns of our strategy to visualize the distributional differences more clearly. Not only is the median return similar but also returns are a lot more consistent over time, as seen by comparing inter-quartile ranges.

Figure 2 – Brazil portfolio annual returns boxplot



To explore the relative performance of our strategy further we split the sample into two: from 2000 to 2010 and then from 2011 to 2020. Table 9 shows descriptive statistics for these two subsamples. A few things are worth noting. Over the 2000 - 2010 period, both our strategy and the IBOVESPA delivered negative excess returns. Although our strategy does provide a somewhat smaller return than the IBOVESPA in this time period, it does so at substantially lower risk, such that the risk-reward of our strategy is almost double that of the IBOVESPA. When we move to the 2011 to 2020 period we see that our strategy offers a higher return than the IBOVESPA with a lot less risk. We remark that in both periods tail-risk loss measures of our approach are vastly preferable. Finally, in both periods the long equities long dollar approach is superior to the long equities short EMBI+ spread alternative.

One worthy final comment is that indeed the returns from our strategy are a lot more consistent than the ones from the IBOVESPA, as already suggested by the boxplot of annual returns. While the return from the 2000-2010 period versus the 2011 to 2020 period was roughly the same for our approcah, IBOVESPA returns fell from an annualized 13% over the first decade to 5.5% over the next. Overall, the Brazilian case is positive for our proposed framework.

Table 9 – Brazil portfolio statistics: subsamples

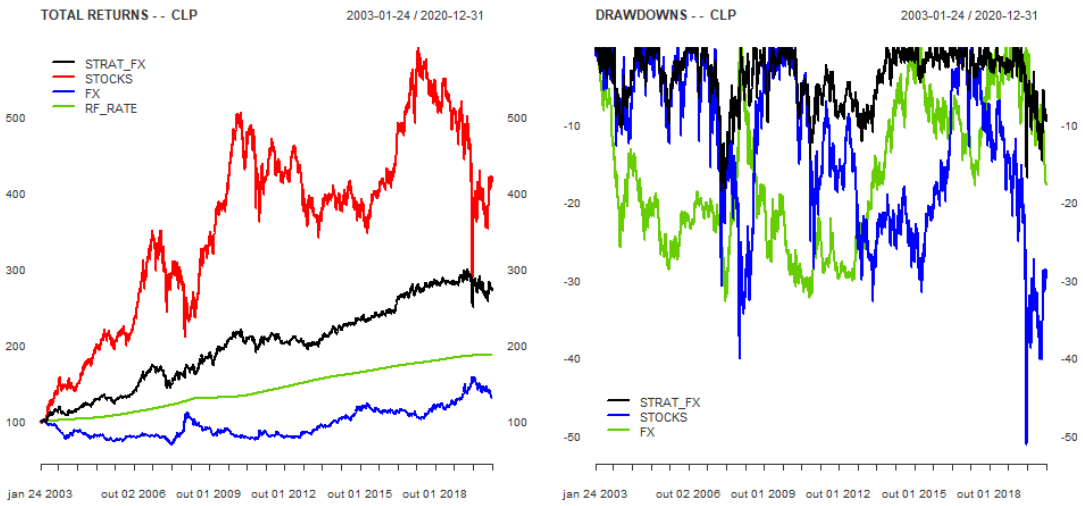
	2000 - 2010			**2011 - 2020**		
	STOCKS/FX	STOCKS/EMBI+	STOCKS	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	10.18	8.38	12.94	10.89	8.31	5.46
EXCESS RETURN	-4.25	-6.06	-1.49	2.19	-0.40	-3.25
VOLATILITY	13.00	16.40	31.63	11.04	14.15	25.78
BETA	0.31	0.44	1.00	0.33	0.47	1.00
RISK REWARD	0.78	0.51	0.41	0.99	0.59	0.21
SHARPE	-0.33	-0.37	-0.05	0.20	-0.03	-0.13
SORTINO	-0.31	-0.37	-0.04	0.19	-0.03	-0.12
TREYNOR	-13.66	-13.89	-1.49	6.68	-0.85	-3.25
SHORTFALL 95% RR	5.87	3.81	2.98	7.23	4.65	1.54
SHORTFALL 95% SHARPE	-2.45	-2.76	-0.34	1.45	-0.22	-0.92
SKEW	-0.06	0.44	0.09	-0.19	1.59	-0.55
KURTOSIS	5.98	9.71	8.17	8.10	28.52	14.08
SHORTFALL 95%	-1.73	-2.20	-4.34	-1.51	-1.79	-3.54
MAX DRAWDOWN	-19.41	-27.27	-59.96	-17.88	-22.50	-47.65

1. Statistics are annualized from the daily geometric mean and standard deviation.

5.3 Chile

The results of our proposed investment framework for Chile are displayed below. We recall that we do not have the EMBI+ total return series for Chile and were therefore unable to construct the alternative EMBI+ portfolio in this case.

Figure 3 – Chile portfolio time-series: full sample



(a) Returns (b) Drawdowns

Table 10 – Chile portfolio statistics: full sample

	2003 - 2020	
	STOCKS/FX	STOCKS
RETURN	5.43	7.73
EXCESS RETURN	2.03	4.34
VOLATILITY	8.39	16.87
BETA	0.39	1.00
RISK REWARD	0.65	0.46
SHARPE	0.24	0.26
SORTINO	0.23	0.24
TREYNOR	5.20	4.34
SHORTFALL 95% RR	4.55	3.18
SHORTFALL 95% SHARPE	1.71	1.78
SKEW	-0.10	-0.50
KURTOSIS	7.61	23.49
SHORTFALL 95%	-1.19	-2.43
MAX DRAWDOWN	-18.36	-51.09

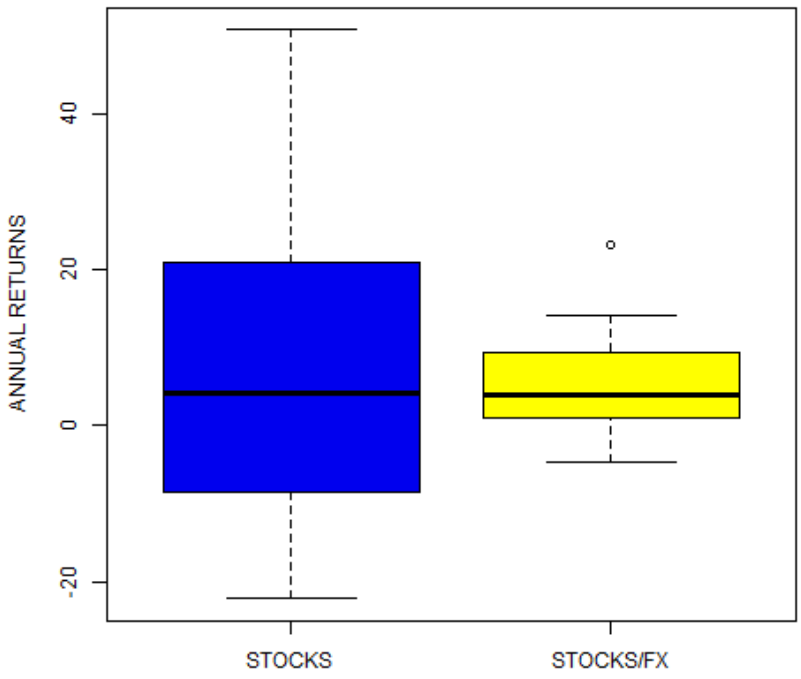
1. Statistics are annualized from the daily geometric mean and standard deviation.

Results for Chile are less clear-cut than for Brazil but are still constructive. Our proposed framework delivers good returns and diminishes risk significantly, reducing volatility by one half and tail-risk statistics such as the 95% expected shortfall and the

maximum drawdown by more than one half. Our strategy is also less negatively skewed than the IPSA and has significantly less kurtosis. However, the strategy does take a toll on the total return and when we look at risk-return metrics the evidence is somewhat conflicting. The Sharpe and Sortino ratios are very similar, while both risk-reward ratios and the Treynor ratio favor our strategy slightly. We draw attention to the fact that when we look simply at *absolute* returns our strategy is able to offer very robust returns with significantly less tail-risk loss.

The boxplot of annual returns in the Chilean case brings similar conclusions as the Brazilian case. Annual returns are a lot more consistent in our strategy, such that we are less dependent on one or two very good years of stock performance. In fact, the median annual return is even slightly higher for our strategy even though the geometric average return over the full sample period is smaller. Return dispersion is markedly more attractive.

Figure 4 – Chile portfolio annual returns boxplot



We split the sample into two as we did in the Brazilian case to gain further insights. In the Chilean case, although our strategy does reduce risk between 2003 and 2010, the toll it takes on return delivers less attractive risk-return ratios than the IPSA during that period. Yet our approach still delivers solid returns in this period with much lower risk. In the 2011 to 2020 subperiod, our strategy is able to deliver higher returns at lower risk. Finally, we again point out that our strategy produces more consistent returns between the two subperiods.

Table 11 – Chile portfolio statistics: subsamples

	2003 - 2010		**2011 - 2020**	
	STOCKS/FX	STOCKS	STOCKS/FX	STOCKS
RETURN	9.24	19.50	2.40	-1.60
EXCESS RETURN	5.71	15.96	-0.88	-4.88
VOLATILITY	8.59	16.63	8.22	17.05
BETA	0.40	1.00	0.38	1.00
RISK REWARD	1.08	1.17	0.29	-0.09
SHARPE	0.66	0.96	-0.11	-0.29
SORTINO	0.61	0.86	-0.10	-0.27
TREYNOR	14.15	15.96	-2.30	-4.88
SHORTFALL 95% RR	7.58	8.06	2.07	-0.66
SHORTFALL 95% SHARPE	4.68	6.60	-0.76	-2.00
SKEW	-0.15	0.31	-0.07	-1.11
KURTOSIS	4.86	16.42	10.20	28.67
SHORTFALL 95%	-1.22	-2.42	-1.16	-2.43
MAX DRAWDOWN	-18.36	-39.96	-16.69	-51.09

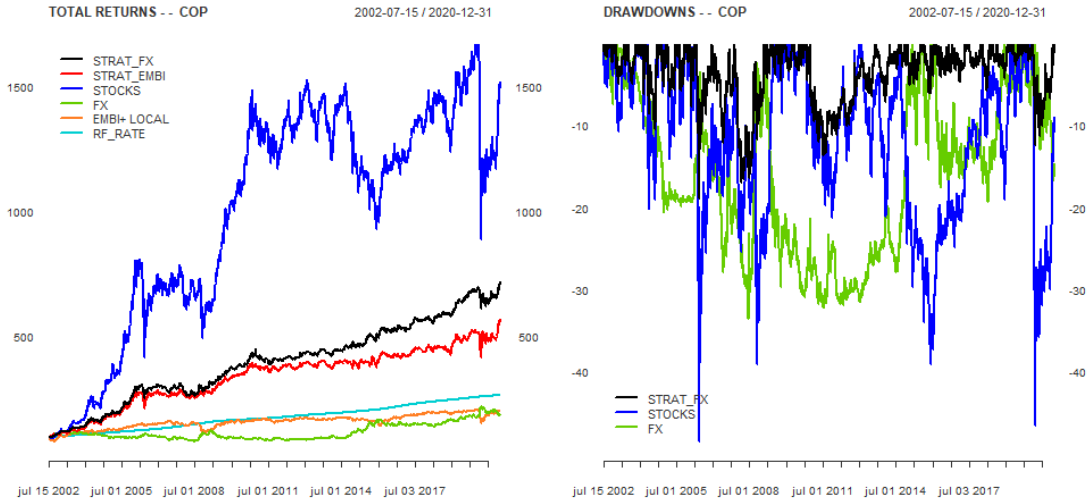
1. Statistics are annualized from the daily geometric mean and standard deviation.

All things considered, we label the Chilean case as positive for our strategy. Robust returns, reduced risk and increased consistency of our strategy gives it a relevant edge over the IPSA.

5.4 Colombia

The results of our proposed investment framework for Colombia are displayed below.

Figure 5 – Colombia portfolio time-series: full sample



(a) Returns (b) Drawdowns

Table 12 – Colombia portfolio statistics: full sample

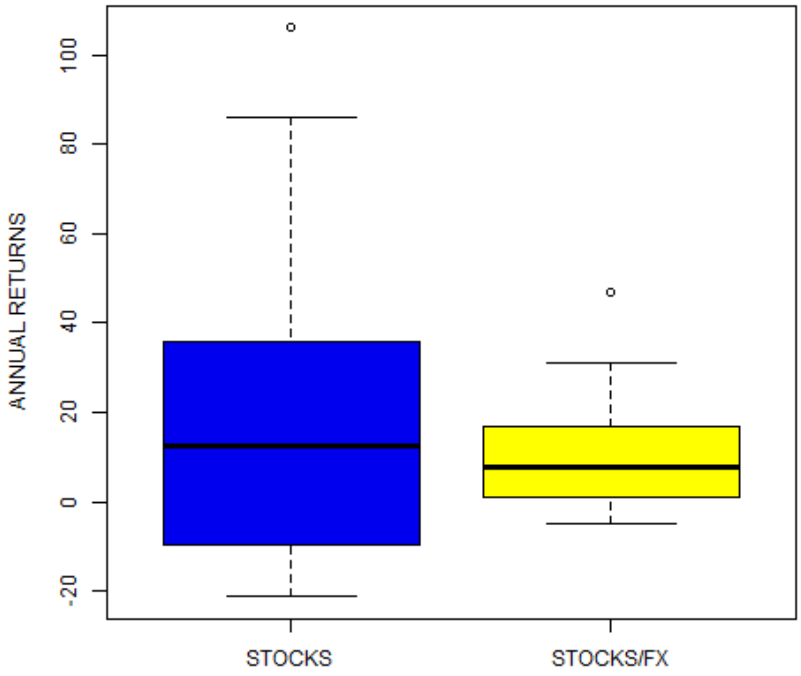
	2002 - 2020		
	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	10.74	9.51	14.85
EXCESS RETURN	5.37	4.15	9.49
VOLATILITY	9.54	11.24	20.63
BETA	0.36	0.44	1.00
RISK REWARD	1.13	0.85	0.72
SHARPE	0.56	0.37	0.46
SORTINO	0.53	0.37	0.41
TREYNOR	14.92	9.43	9.49
SHORTFALL 95% RR	8.00	6.13	4.89
SHORTFALL 95% SHARPE	4.00	2.67	3.13
SKEW	0.05	1.07	0.03
KURTOSIS	9.23	21.78	32.86
SHORTFALL 95%	-1.34	-1.55	-3.04
MAX DRAWDOWN	-18.89	-24.65	-48.57

1. Statistics are annualized from the daily geometric mean and standard deviation.

The results for Colombia are positive for our framework. Risk-return metrics are higher across the board (risk-reward, Sharpe, Sortino and Treynor). Furthermore, tail-risk statistics are broadly preferable, reducing stress metrics by one third and with more

attractive skewnewss and kurtosis statistics. The box-plot of annual returns once again highlights the higher consistency of our strategy in comparison to the COLCAP.

Figure 6 – Colombia portfolio annual returns boxplot



When looking at the subperiod analysis in Table 13 we find something interesting. Over the 2002 - 2010 period, the risk-return metrics of our strategy vs. the COLCAP are similar. In the 2011 - 2020 period, however, our strategy offers higher return with lower risk. Over both periods, our framework performs better than the alternative 50% long equities and 50% short EMBI+ spread. Overall, the Colombian case is also positive for our framework.

Table 13 – Colombia portfolio statistics: subsamples

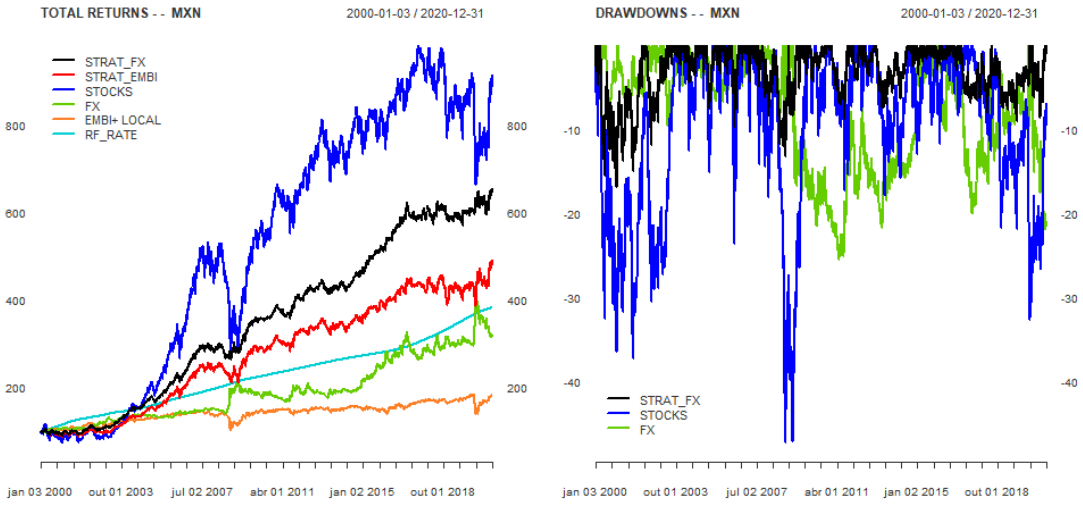
	2002 - 2010			**2011 - 2020**		
	STOCKS/FX	STOCKS/EMBI+	STOCKS	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	17.53	16.12	31.54	4.99	3.35	0.73
EXCESS RETURN	11.09	9.68	25.10	0.54	-1.10	-3.72
VOLATILITY	10.94	12.59	23.80	8.14	8.66	17.47
BETA	0.38	0.44	1.00	0.32	0.38	1.00
RISK REWARD	1.60	1.28	1.32	0.61	0.39	0.04
SHARPE	1.01	0.77	1.05	0.07	-0.13	-0.21
SORTINO	0.93	0.73	0.91	0.06	-0.13	-0.19
TREYNOR	28.96	22.24	25.10	1.67	-2.90	-3.72
SHORTFALL 95% RR	11.23	9.06	8.95	4.36	2.85	0.29
SHORTFALL 95% SHARPE	7.11	5.44	7.12	0.47	-0.93	-1.46
SKEW	0.04	0.44	0.40	-0.03	1.08	-0.91
KURTOSIS	9.03	13.45	25.76	7.10	17.90	42.54
SHORTFALL 95%	-1.56	-1.78	-3.52	-1.15	-1.18	-2.55
MAX DRAWDOWN	-18.89	-24.65	-48.57	-12.35	-17.45	-46.64

1. Statistics are annualized from the daily geometric mean and standard deviation.

5.5 Mexico

The results of our proposed investment framework for Mexico are displayed below.

Figure 7 – Mexico portfolio time-series: full sample



(a) Returns (b) Drawdowns

Table 14 – Mexico portfolio statistics: full sample

	2000 - 2020		
	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	9.02	7.61	10.59
EXCESS RETURN	2.54	1.14	4.11
VOLATILITY	9.44	11.39	20.39
BETA	0.37	0.48	1.00
RISK REWARD	0.96	0.67	0.52
SHARPE	0.27	0.10	0.20
SORTINO	0.26	0.10	0.19
TREYNOR	6.94	2.35	4.11
SHORTFALL 95% RR	6.92	4.99	3.57
SHORTFALL 95% SHARPE	1.95	0.75	1.39
SKEW	0.04	1.11	0.13
KURTOSIS	5.73	19.90	8.90
SHORTFALL 95%	-1.30	-1.52	-2.97
MAX DRAWDOWN	-16.77	-18.20	-47.17

1. Statistics are annualized from the daily geometric mean and standard deviation.

In the Mexican case, we see that our strategy has substantially less risk than simply investing in the MEXBOL. The volatility is less than half that of the MEXBOL, and the 95% expected shortfall and maximum drawdown are significantly lower. Although our framework results in a lower return than the MEXBOL it still yields a good return. Moreover, when looking at risk-return ratios they are all higher for our proposed framework.

Our framework is also strictly better than the alternative 50% long stocks and 50% short EMBI+. Although the alternative EMBI+ portfolio does significantly reduce risk it takes a larger toll on return, such that risk-return characteristics of our proposed framework are more attractive.

The boxplot of annual returns has conclusion in line with previous analyses: returns are a lot more consistent for our strategy, and the median return is similar to equities.

Figure 8 – Mexico portfolio annual returns boxplot

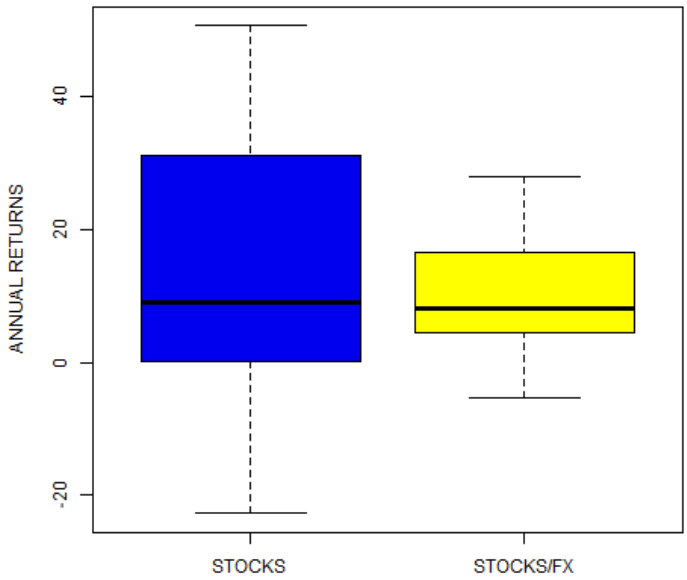


Table 15 – Mexico portfolio statistics: subsamples

	2000 - 2010			**2011 - 2020**		
	STOCKS/FX	STOCKS/EMBI+	STOCKS	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	12.51	10.75	17.40	5.17	3.62	3.09
EXCESS RETURN	4.70	2.94	9.59	0.17	-1.38	-1.91
VOLATILITY	10.73	11.96	23.86	7.78	8.32	15.72
BETA	0.39	0.45	1.00	0.31	0.41	1.00
RISK REWARD	1.17	0.90	0.73	0.67	0.43	0.20
SHARPE	0.44	0.25	0.40	0.02	-0.17	-0.12
SORTINO	0.42	0.24	0.37	0.02	-0.17	-0.11
TREYNOR	12.10	6.49	9.59	0.56	-3.36	-1.91
SHORTFALL 95% RR	8.53	6.65	5.14	4.94	3.27	1.34
SHORTFALL 95% SHARPE	3.21	1.82	2.84	0.17	-1.25	-0.83
SKEW	-0.01	0.25	0.23	0.09	0.78	-0.39
KURTOSIS	5.38	6.17	7.81	4.72	13.92	7.19
SHORTFALL 95%	-1.47	-1.62	-3.38	-1.05	-1.10	-2.31
MAX DRAWDOWN	-16.77	-18.20	-47.17	-8.98	-11.58	-32.52

1. Statistics are annualized from the daily geometric mean and standard deviation.

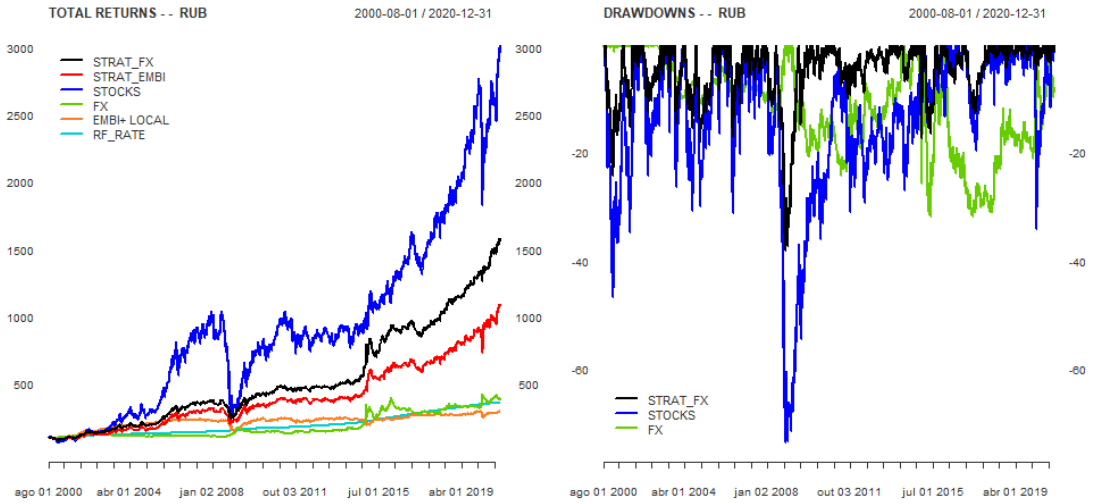
Looking at different subperiods the preference for our strategy remains. In the 2000 to 2010 period our strategy has a lower return but vastly lower risk exposure, such

that the risk-return metrics favor it over our two alternatives. In the 2011 to 2020 period our strategy offers higher return with lower risk. Last but not least, we note that our strategy offers a lot more consistent returns: the drop in returns between the first and second sample periods is a lot more dramatic for the MEXBOL than for our proposed framework. Overall, the Mexican case is positive for our proposed framework.

5.6 Russia

The results of our proposed investment framework for Russia are displayed below.

Figure 9 – Russia portfolio time-series: full sample



(a) Returns (b) Drawdowns

Table 16 – Russia portfolio statistics: full sample

	2000 - 2020		
	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	13.68	11.86	16.87
EXCESS RETURN	7.29	5.47	10.48
VOLATILITY	15.05	17.61	31.04
BETA	0.43	0.50	1.00
RISK REWARD	0.91	0.67	0.54
SHARPE	0.48	0.31	0.34
SORTINO	0.45	0.30	0.31
TREYNOR	17.01	10.97	10.48
SHORTFALL 95% RR	6.26	4.63	3.62
SHORTFALL 95% SHARPE	3.34	2.13	2.25
SKEW	-0.04	0.51	0.22
KURTOSIS	17.78	18.82	23.51
SHORTFALL 95%	-2.18	-2.56	-4.65
MAX DRAWDOWN	-37.94	-38.13	-73.65

1. Statistics are annualized from the daily geometric mean and standard deviation.

Russia is another success case for our framework, presenting risk-return metrics that are broadly favorable both over the full-sample and over the two subperiods investigated. Returns are attractive and consistent, and tail-risk loss estimates much more controlled. We remark that since the government debt crisis of 1998 Russia has gradually moved towards a more floating exchange rate regime although the countries' currency remained

largely managed until 2014. Although this does not seem to have affect the underlying positive results of our framework, we note that this probably affects its efficacy throughout the period. All things considered, Russia is another positive example for our framework.

Figure 10 – Russia portfolio annual returns boxplot

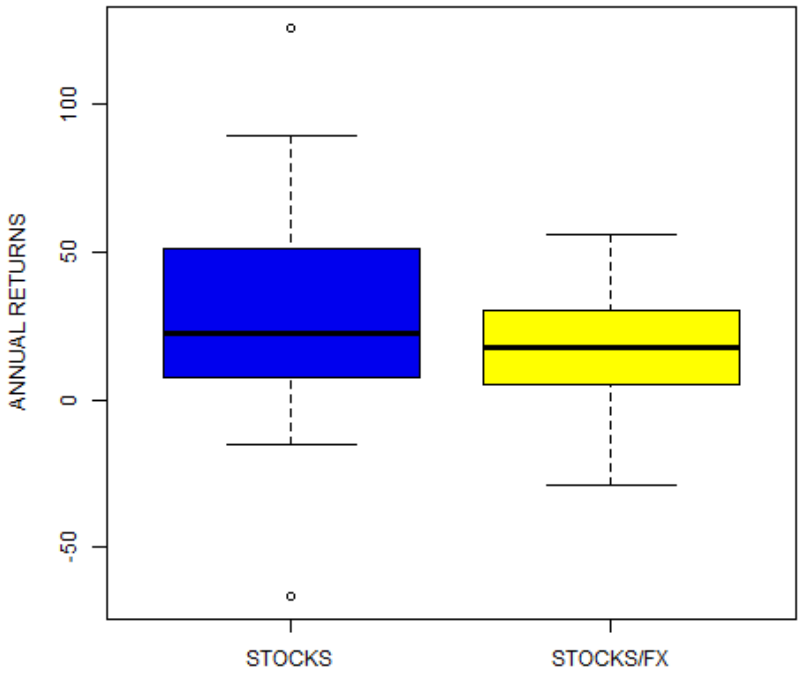


Table 17 – Russia portfolio statistics: subsamples

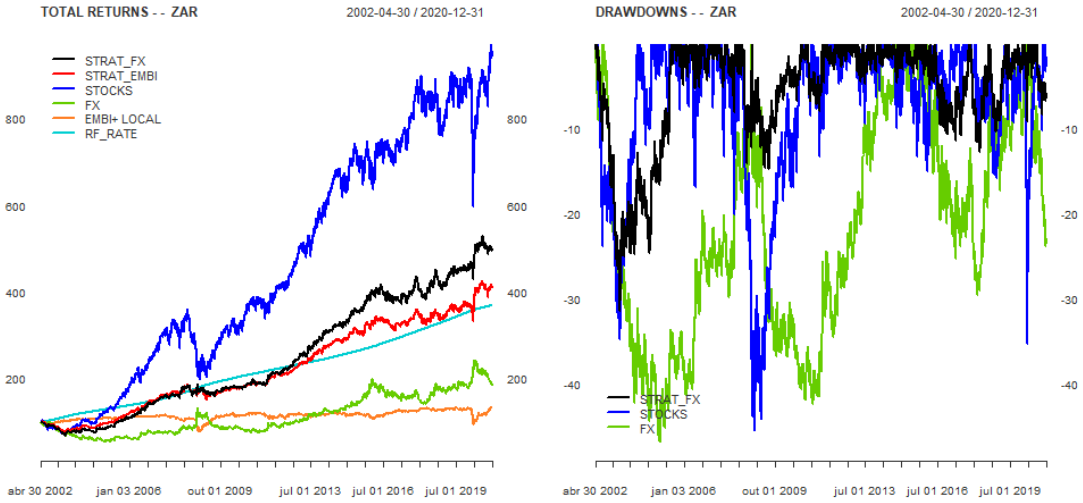
	2000 - 2010			**2011 - 2020**		
	STOCKS/FX	STOCKS/EMBI+	STOCKS	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	15.27	13.28	21.80	12.02	9.59	11.73
EXCESS RETURN	9.76	7.77	16.29	4.71	2.29	4.43
VOLATILITY	17.68	20.15	38.95	11.70	11.36	19.79
BETA	0.44	0.47	1.00	0.37	0.46	1.00
RISK REWARD	0.86	0.66	0.56	1.03	0.84	0.59
SHARPE	0.55	0.39	0.42	0.40	0.20	0.22
SORTINO	0.50	0.36	0.37	0.39	0.20	0.20
TREYNOR	22.08	16.43	16.29	12.59	4.94	4.43
SHORTFALL 95% RR	5.78	4.42	3.80	7.98	6.31	4.02
SHORTFALL 95% SHARPE	3.70	2.59	2.84	3.13	1.51	1.52
SKEW	-0.26	-0.30	0.28	0.70	1.66	-0.71
KURTOSIS	8.52	7.86	18.02	52.72	32.95	10.49
SHORTFALL 95%	-2.64	-3.00	-5.74	-1.51	-1.52	-2.92
MAX DRAWDOWN	-37.94	-38.13	-73.65	-17.30	-15.21	-34.15

1. Statistics are annualized from the daily geometric mean and standard deviation.

5.7 South Africa

The results of our proposed investment framework for South Africa are displayed below.

Figure 11 – South Africa portfolio time-series: full sample



(a) Returns (b) Drawdowns

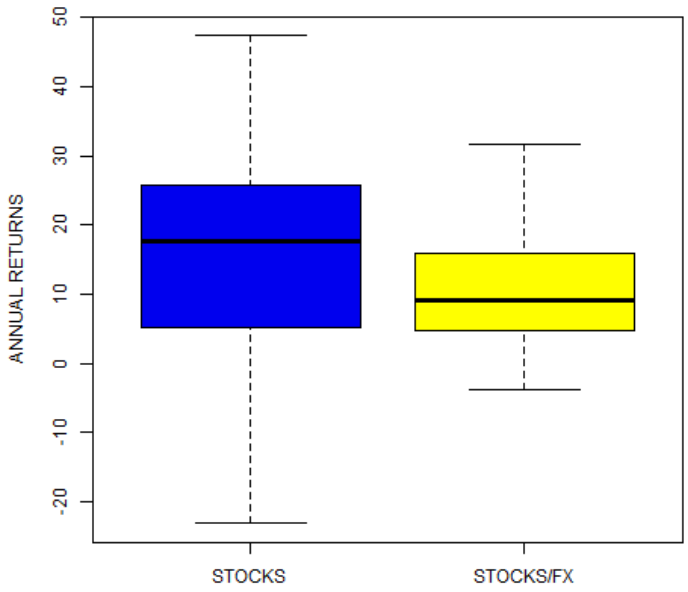
Table 18 – South Africa portfolio statistisc: full sample

	2002 - 2020		
	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	8.71	7.69	12.20
EXCESS RETURN	1.63	0.61	5.12
VOLATILITY	11.96	9.96	19.46
BETA	0.40	0.42	1.00
RISK REWARD	0.73	0.77	0.63
SHARPE	0.14	0.06	0.26
SORTINO	0.14	0.06	0.24
TREYNOR	4.11	1.44	5.12
SHORTFALL 95% RR	5.58	5.74	4.31
SHORTFALL 95% SHARPE	1.04	0.46	1.81
SKEW	0.25	0.50	-0.21
KURTOSIS	5.68	9.86	8.29
SHORTFALL 95%	-1.56	-1.34	-2.83
MAX DRAWDOWN	-31.29	-24.52	-45.32

1. Statistics are annualized from the daily geometric mean and standard deviation.

South Africa is the first country within our sample for which our framework is not superior to the local stock market index (the JALSH) over the full sample. Although our strategy still provides good returns and relevant risk reduction, the value add is less clear than in the other countries studied so far. Although our strategy has higher risk-reward

Figure 12 – South Africa portfolio annual returns boxplot



ratios, the JALSH has higher Sharpe, Sortino and Treynor ratios. The skewness and kurtosis of our framework is more attractive, but while in other cases tail-risk losses measures were reduced by more than one half, in South Africa they are also reduced but not by that much. Finally, looking at the boxplot of annual returns South Africa is the first country for which the median stock annual return is significantly higher than our proposed framework, thus compensating for the added return dispersion. Ultimately, there is no clear standout between the two over the full sample. We also note that, once again, our proposed mix of equities and foreign exchange outperforms the alternative equities and EMBI+ spread combination.

Table 19 – South Africa portfolio statistics: subsamples

	2002 - 2010			**2011 - 2020**		
	STOCKS/FX	STOCKS/EMBI+	STOCKS	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	7.34	7.45	15.50	9.90	7.95	9.34
EXCESS RETURN	-1.34	-1.23	6.83	4.21	2.26	3.65
VOLATILITY	13.57	10.69	21.88	10.37	9.35	17.10
BETA	0.40	0.41	1.00	0.39	0.45	1.00
RISK REWARD	0.54	0.70	0.71	0.95	0.85	0.55
SHARPE	-0.10	-0.11	0.31	0.41	0.24	0.21
SORTINO	-0.10	-0.11	0.29	0.41	0.24	0.19
TREYNOR	-3.31	-2.99	6.83	10.90	5.02	3.65
SHORTFALL 95% RR	4.16	5.13	4.96	7.45	6.43	3.75
SHORTFALL 95% SHARPE	-0.76	-0.84	2.19	3.17	1.83	1.46
SKEW	0.31	0.36	-0.01	0.15	0.69	-0.58
KURTOSIS	5.69	8.33	6.47	4.32	12.06	10.93
SHORTFALL 95%	-1.76	-1.45	-3.12	-1.33	-1.24	-2.49
MAX DRAWDOWN	-31.29	-24.52	-45.32	-12.65	-12.66	-35.20

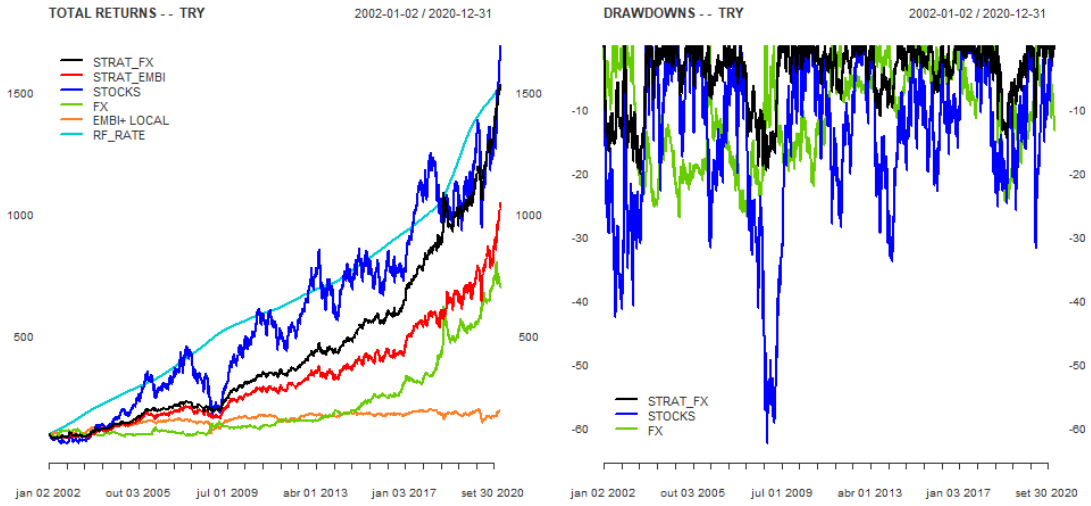
1. Statistics are annualized from the daily geometric mean and standard deviation.

When we look at our two sub-samples, however, we note that there is a stark contrast between the two subperiods. In the first, the JALSH is largely superior while in the second our framework is able to deliver higher return at much lower risk. Overall, the South African case is neutral for our framework. Results over the full sample are contentious and the two-period analysis tells two very different stories, such that it is hard to conclude which investment framework would be preferred *ex-ante*.

5.8 Turkey

The results of our proposed investment framework for Turkey are displayed below.

Figure 13 – Turkey portfolio time-series: full sample



(a) Returns (b) Drawdowns

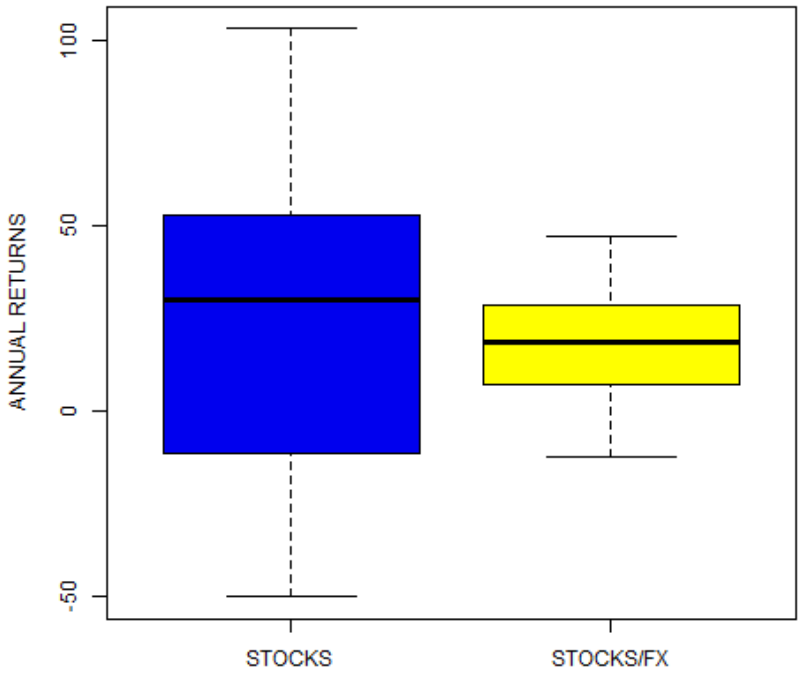
Table 20 – Turkey portfolio statistics: full sample

	2002 - 2020		
	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	14.52	12.49	15.03
EXCESS RETURN	-0.00	-2.03	0.51
VOLATILITY	12.87	16.11	28.38
BETA	0.37	0.49	1.00
RISK REWARD	1.13	0.78	0.53
SHARPE	-0.00	-0.13	0.02
SORTINO	-0.00	-0.13	0.02
TREYNOR	-0.00	-4.15	0.51
SHORTFALL 95% RR	8.12	5.70	3.65
SHORTFALL 95% SHARPE	-0.00	-0.93	0.12
SKEW	0.14	0.69	-0.05
KURTOSIS	8.99	11.96	8.04
SHORTFALL 95%	-1.79	-2.19	-4.12
MAX DRAWDOWN	-20.12	-24.38	-62.39

1. Statistics are annualized from the daily geometric mean and standard deviation.

The Turkish case resembles the Brazilian case because of low or negative excess returns, a byproduct of very high interest rates. Comparing the risk-return metrics of our framework against the local XU100, however, we note that our strategy delivers similar returns with more consistency and with much lower volality and tail-risk measures.

Figure 14 – Turkey portfolio annual returns boxplot



Looking at the sub-sample statistics, negative excess returns in the 2000 to 2010 period complicate comparison but risk-reward ratios largely favor our framework. Meanwhile, during the 2011 to 2010 subperiod our strategy delivered higher excess returns at significantly lower risk. Overall, the Turkish case is positive for our proposed framework.

Table 21 – Turkey portfolio statistics: subsamples

	2002 - 2010			**2011 - 2020**		
	STOCKS/FX	STOCKS/EMBI+	STOCKS	STOCKS/FX	STOCKS/EMBI+	STOCKS
RETURN	13.94	11.52	19.54	15.04	12.00	10.98
EXCESS RETURN	-6.08	-8.50	-0.48	5.47	2.43	1.41
VOLATILITY	14.56	16.71	33.58	11.13	12.75	22.73
BETA	0.37	0.44	1.00	0.37	0.47	1.00
RISK REWARD	0.96	0.69	0.58	1.35	0.94	0.48
SHARPE	-0.42	-0.51	-0.01	0.49	0.19	0.06
SORTINO	-0.41	-0.50	-0.01	0.46	0.19	0.06
TREYNOR	-16.58	-19.47	-0.48	14.78	5.15	1.41
SHORTFALL 95% RR	7.11	5.08	4.17	9.65	6.99	3.24
SHORTFALL 95% SHARPE	-3.10	-3.75	-0.10	3.51	1.42	0.42
SKEW	0.24	0.34	0.11	-0.07	0.92	-0.56
KURTOSIS	6.66	7.06	7.06	13.00	16.03	6.87
SHORTFALL 95%	-1.96	-2.27	-4.68	-1.56	-1.72	-3.38
MAX DRAWDOWN	-20.12	-24.38	-62.39	-14.64	-14.66	-33.90

1. Statistics are annualized from the daily geometric mean and standard deviation.

5.9 Summary and Additional Tests

We have looked at the financial characteristics of our proposed long dollar long equities framework against local stock indexes and against a long equities short EMBI+ spread alternative. We summarize our general conclusions in Table 22. On a risk-adjusted basis, in six of seven cases (Brazil, Chile, Colombia, Mexico, Russia and Turkey) our proposed framework was favored over simply investing in a local stock index. In one case (South Africa) there was a tie due to highly conflicting results in the two different subperiods we study. When comparing to an alternative hedge, namely the EMBI+ spread, our strategy was favored on all applicable cases. All things considered, results are broadly in favor of our framework.

Table 22 – Summary of preferred portfolio decisions

	STRATEGY VS. STOCKS	STRATEGY VS. EMBI+ ALTERNATIVE
BRAZIL	Positive	Positive
CHILE	Positive	Not Applicable
COLOMBIA	Positive	Positive
MEXICO	Positive	Positive
RUSSIA	Positive	Positive
SOUTH AFRICA	Neutral	Positive
TURKEY	Positive	Positive

1. *Positive* signals that our strategy was preferred, *neutral* signals that results were inconclusive and *negative* that alternatives were preferred.

To statistically evaluate the general relative performance of our framework we employ a paired t-test of the difference between risk-reward ratios of our strategy against local stock indices. We work with risk-reward ratios because the occurrence of negative or very small excess returns complicates comparison using the Sharpe, Sortino or Treynor ratios.

Table 23 – Portfolio risk-return differences

	Full Sample			**2000 - 2010**			**2011 - 2020**		
	STOCKS/FX	STOCKS	DIFF.	STOCKS/FX	STOCKS	DIFF.	STOCKS/FX	STOCKS	DIFF.
BRAZIL	0.87	0.32	0.55	0.78	0.41	0.37	0.99	0.21	0.78
MEXICO	0.95	0.52	0.43	1.17	0.73	0.44	0.67	0.20	0.47
SOUTH AFRICA	0.73	0.63	0.10	0.54	0.71	-0.17	0.95	0.55	0.40
TURKEY	1.13	0.53	0.60	0.96	0.58	0.38	1.35	0.48	0.87
CHILE	0.65	0.46	0.19	1.08	1.17	-0.09	0.29	-0.09	0.38
COLOMBIA	1.13	0.72	0.41	1.60	1.32	0.28	0.61	0.04	0.57
RUSSIA	0.91	0.54	0.37	0.86	0.56	0.30	1.03	0.59	0.44
AVERAGE	0.91	0.53	0.38	1.00	0.78	0.22	0.84	0.28	0.56
T-TEST P-VALUE			0.00			0.06			0.00

1. Statistics are annualized from the daily geometric mean and standard deviation.

Over the full sample and over the 2011 to 2020 subperiod we find a statistically significant difference between risk-reward ratios of our strategy against local stock indices at the 5% level. In the 2000 to 2010 period the p-value just misses the 5% cut-off and we find a significant difference only at the 10% level. Overall, there is good evidence that our strategy is able to provide superior risk-adjusted returns compared to the local stock index.

One final attribute of our strategy that is worth underlining is the significant tail-risk loss reduction it provides. As table 24 illustrates, the 95% expected shortfall of our framework is less than half that of local stock indices, on average, over the full sample.[4] Indeed, as we observed on the case-by-case analyses, drawdowns for our strategy are significantly reduced. The average tail-risk loss reduction of our strategy is statistically significant even at a required 1% confidence level.

Table 24 – Portfolio daily 95% expected shortfall: full sample

	STOCKS/FX	STOCKS
BRAZIL	-1.64	-4.04
MEXICO	-1.30	-2.96
SOUTH AFRICA	-1.56	-2.83
TURKEY	-1.79	-4.12
CHILE	-1.19	-2.43
COLOMBIA	-1.34	-3.04
RUSSIA	-2.18	-4.65
AVERAGE	-1.57	-3.44

All in all, our simple framework is able to provide robust returns with much lower risk than a pure stock indexing approach. Volatility and tail-risk loss are greatly reduced by hedging risk through dollar exposure, all the while still producing solid returns. Ultimately, the benefit of adding a currency hedge for country risk in a portfolio is that it reduces risk without significantly compromising long-term returns; investors are rewarded in the long-run from a combination of the equity premium and purchasing power parity, and are protected from adverse short-run fluctuations due to the inverse relationship that stocks and currencies have with risk.

Last, we highlight that one novel and particularly interesting takeaway from our analysis is that, even from the point of view of a domestic investor, holding a certain amount of US dollars in a local stock equity portfolio is desirable. Previous literature has focused more on currency risk and on the point of view of international portfolio managers investing abroad.

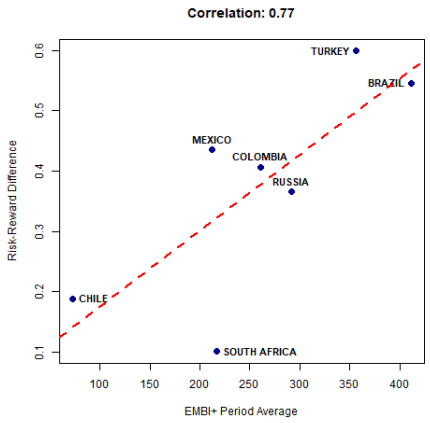
[4]The conclusion is similar on the two alternative sub-samples.

6 DOES THE LEVEL OF COUNTRY RISK MATTER?

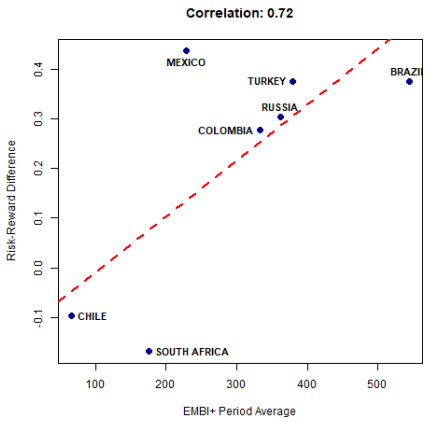
Having established that our strategy generally provides attractive risk-adjusted returns, we make a brief foray into what particular situations benefit our framework. Since our *ex-ante* goal was to hedge country risk in a way that does not significantly compromise long-term returns, one hypothesis is that the best rewards for our framework come in situations where country risk is more pervasive. To test this hypothesis we plot the difference in risk-reward ratios between our strategy and the relevant stock index against the average EMBI+ spread for that country during a given period. In this setting, a higher average EMBI+ spread signals greater country risk during that period. We choose to work with risk-reward ratios in this analysis because of the occurrence of negative Sharpe ratios, which complicates comparison and interpretation.

Figure 15 – Mean EMBI+ spread versus risk-return differential

(a) Full Sample



(b) 2000 - 2010



(c) 2011 - 2020

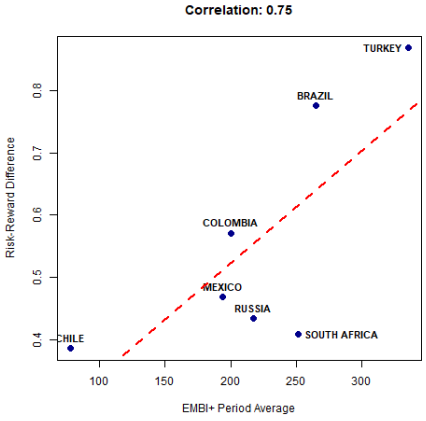


Figure 15 shows there is a positive relationship between the amount of country risk and the added value of our strategy: higher EMBI+ averages strongly correlate with more positive differences between the risk-reward of our strategy when compared to local stock market indices. We run a simple linear regression to determine if this correlation is statistically significant.

Table 25 – Risk-Reward benefit vs. EMBI+ spread average regression

	Beta Estimate	T-Statistic	P-Value
Full Sample	0.13	2.69	0.04
2000 - 2010	0.11	2.31	0.07
2011 - 2020	0.18	2.50	0.06

1. Model specification: $RR_{Strategy_t} - RR_{Stocks_t} = \alpha + \beta_1 Avg.EMBI.Spread_t + \varepsilon_t$

The results of our linear regression show some evidence for the proposition that our framework adds more value in markets where country risk is most prominent. For the full sample, the relationship between the risk-reward differential of our strategy against stocks and the average EMBI+ spread is significant at the 5% level. A country with a mean EMBI+ spread 100 points larger will have a risk-reward differential that is 0.13 greater, on average, in that period. Individually within our two subsamples, the relationship is significant at the 10% level but does not quite make the 5% cut-off. We remark that these regressions have a low number of degrees of freedom (5), such that firmly rejecting the null hypothesis requires a very strong relation. All things considered, we find these results supportive of the hypothesis that our framework adds more value in higher country risk markets.

7 PORTFOLIO OPTIMIZATION

Up to now we used a symmetric 50/50 equity/FX allocation in our analysis. In this chapter we use optimization to calculate ideal weights for our strategy. Importantly, we include the local risk-free rate as an investment option. Therefore investors have three investment options: (1) the local stock index, (2) the US dollar and (3) the local risk-free rate. In this setting, initial equity, dollar and risk-free portfolio weights are set at w_{e_1}, w_{d_1} and w_{r_1} respectively, where $w_{e_1} + w_{d_1} + w_{r_1} = 1$. Portfolio weights are rebalanced quarterly. Given portfolio weights at time t and equity ($r_{e_{t+1}}$), dollar ($r_{d_{t+1}}$) and risk-free ($r_{r_{t+1}}$) total returns at time $t+1$, the total return of the portfolio at time $t+1$ is given by:

$$r_{p_{t+1}} = r_{e_{t+1}} w_{e_t} + r_{d_{t+1}} w_{d_t} + r_{r_{t+1}} w_{r_t}$$

Portfolio weights are subsequently given by

$$w_{e_{t+1}} = \frac{w_{e_t}(1 + r_{e_{t+1}})}{w_{e_t}(1 + r_{e_{t+1}}) + w_{d_t}(1 + r_{d_{t+1}}) + w_{r_t}(1 + r_{r_{t+1}})}$$

$$w_{d_{t+1}} = \frac{w_{d_t}(1 + r_{d_{t+1}})}{w_{e_t}(1 + r_{e_{t+1}}) + w_{d_t}(1 + r_{d_{t+1}}) + w_{r_t}(1 + r_{r_{t+1}})}$$

$$w_{r_{t+1}} = \frac{w_{r_t}(1 + r_{r_{t+1}})}{w_{e_t}(1 + r_{e_{t+1}}) + w_{d_t}(1 + r_{d_{t+1}}) + w_{r_t}(1 + r_{r_{t+1}})}$$

We optimize over the Sharpe ratio and over the risk-reward ratio, comparing results and checking whether our previous conclusions are robust to optimized weight selection and to inclusion of the local risk-free rate as a risk-reducing investment alternative.

Naturally, the inclusion of the risk-free rate in a no-leverage scenario complicates numerical optimization because both the numerator and denominator tend to zero as allocation to the risk-free rate increases. What we do is optimize over a range of pre-determined risk-free rate allocations. For example, what is the optimal ratio of stocks and foreign exchange in a portfolio that has a fixed 50% allocation to the risk-free rate? We do this for a range of risk-free allocations, from 0% to 90% in steps of 10%, and interpret results. Thus we run 10 optimization procedures for each country. We present the full optimization results for each country in Appendix D.

Table 26 – Sharpe Ratio optimal average equity/FX left-over allocation

	STOCK TARGET %	FX TARGET %
BRAZIL	100	0
MEXICO	55	45
SOUTH AFRICA	84	16
TURKEY	76	24
CHILE	79	21
COLOMBIA	60	40
RUSSIA	41	59
MEAN	71	29
MEAN EX-BRAZIL	66	34

Table 26 shows average stock and foreign exchange weights as a proportion of the left-over risk-free allocation across all ten optimizations. Even after including the risk-free rate, the optimizer still allocates around 30% of the left-over portfolio risk to foreign exchange. Remarkably, the Brazilian case is one where there is no foreign exchange allocation. Although this may seem extreme, it occurs because Brazil presents negative excess returns over the full sample. When excess return is in negative territory the optimizer will look for more return and more volatility (since a larger divisor means a higher numerical Sharpe ratio). As a result, the optimizer allocates risk fully to equities in the Brazil case.

To circumvent the Sharpe ratio complication and obtain additional insights we also optimized over the risk-reward ratio. Results are displayed in Table 27 and are quite different from the Sharpe ratio optimizations. When maximizing over the risk-reward ratio the average left-over allocation to foreign exchange increases markedly, to 59%.

Table 27 – Risk-reward optimal average equity/FX left-over allocation

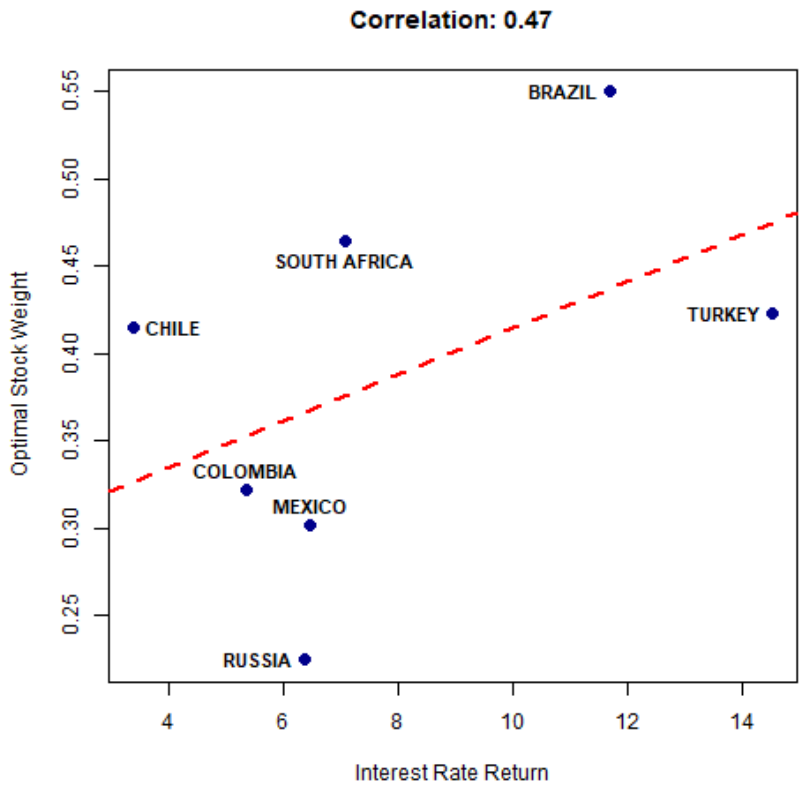
	STOCK TARGET %	FX TARGET %
BRAZIL	38	62
MEXICO	38	62
SOUTH AFRICA	59	41
TURKEY	34	66
CHILE	45	55
COLOMBIA	44	56
RUSSIA	32	68
MEAN	41	59

The choice of which risk metric to optimize over drastically influences the optimal allocation. Indeed, Sharpe ratios focus heavily on excess returns. Consider a 10% volatility stock that realized a return of 6% against a risk-free rate of 3%. All else equal, if the return of this stock increases to 9% the Sharpe ratio will double from 0.3 to 0.6. The risk-reward

ratio will increase from 0.6 to 0.9, a much less pronounced jump. Optimizing over Sharpe ratios emphasizes excess return maximization and therefore motivates a higher equity allocation. In any case, both when optimizing over Sharpe ratios and when optimizing over the risk-reward rate, a relevant foreign exchange allocation is recommended.

The results in Tables 26 also led us to briefly investigate whether there was a relationship between interest rate levels and the Sharpe-optimized stock weight. Our *ex-ante* hypothesis was that high interest rates would lead to a higher requested stock weight in the Sharpe ratio maximization process, aiming at higher excess returns. Figure 16 suggests some positive correlation, but linear regression analysis resulted in a p-value of 0.29 for the interest rate coefficient: countries with higher interest rates do not have statistically significantly higher Sharpe-optimized stock weights, on average.

Figure 16 – Interest rate return versus optimized Sharpe ratio stock weight: 2000-2020



In the end, the portfolio optimization exercise in this chapter supports previous results, suggesting that coupling equities and foreign exchange is a sound risk-adjusted investment framework. Depending on which risk metric any given portfolio manager might prefer the portfolio may tilt slightly to stocks or foreign exchange. The overarching message, however, is the same: it would generally be advisable to hedge every unit of stock risk with some amount of a safe-haven currency, in this case the US dollar.

8 CONCLUSION

In this dissertation we studied the relationship between equities and currencies in seven emerging markets and drew upon the economic implications of our findings to propose a long equities long dollar investment framework that harvests long-term equity-like returns while hedging out burdensome country risk. Our study makes four contributions to pre-existing literature:

(1) First, using linear regression analysis we found that the observed negative correlation between equities and stocks derives largely from country risk. After controlling for country risk and expanding the time horizon, the covariation between stocks and foreign exchange is not statistically significant. These results are robust to several regression tests and different sub-periods, and they apply to all seven emerging markets we study.

(2) Second, we combined these results with finance theory (the equity premium) and economic theory (purchasing power parity) to propose an economically sound and financially attractive long equities long dollar investment framework. On one hand, investors are rewarded over the long-run through a combination of the equity premium and purchasing power parity of higher inflation emerging markets. On the other hand, the inverse exposure that equities and currencies have to country risk significantly reduces portfolio risk. Our proposed framework outperforms local stock indices on a risk-adjusted basis in six of seven studied emerging markets (Brazil, Chile, Colombia, Mexico, Russia and Turkey); one case (South Africa) is neutral. In all seven cases our framework is better than an alternative strategy that uses the EMBI+ spread as a hedge instead of the US dollar. On average, our strategy provides risk-reward ratios that are 0.38 higher than local stock indices. This result is statistically significant at the 5% level. Tail-risk loss is also substantially reduced in our framework. Ultimately, we show that our framework delivers superior risk-adjusted returns and argue that, because it is grounded on financial and economic theory, these returns can be expected to prevail in the long-term.

Taken together with (1), these conclusion are novel and particularly interesting because they mean that, even from the point of view of a domestic investor, holding a certain amount of US dollars in a local stock equity portfolio is desirable. Previous literature has largely focused on the point of view of international portfolio managers investing abroad, but we show that the risk-minimizing properties of safe-haven currencies is relevant for domestic and foreign investors alike. Naturally, since our hedging instrument is the US dollar our framework also offers currency risk protection.

(3) Third, we presented evidence suggesting that our strategy adds more value in higher risk environments. The difference between risk-reward ratios of our strategy against local stock indices is statistically significantly higher in countries that have a higher EMBI+ spread. Regression estimates over the full sample period indicate that our strategy will provide an additional 0.13 risk-reward benefit over local equities for every 100 points of EMBI+ spread, on average.

(4) Last, our findings were reinforced through a portfolio optimization exercise that optimally allocated a non-leveraged portfolio among equities, foreign exchange and the risk-free rate. Some foreign exchange allocation is optimal both when optimizing the Sharpe ratio and when optimizing the risk-reward ratio. Optimizing over the Sharpe ratio generally suggests a higher relative equity/FX left-over allocation of around 70%/30%, while optimizing over risk-reward ratio cautions a more conservative 40%/60% portfolio. Importantly, these weights apply to the portion of portfolio risk left-over after allocating a desired portion to the risk-free.

The analysis of this dissertation may be extended in several ways. For one thing, the number of emerging market economics could be expanded, in particular including some Asian countries. For another, the amount of currencies could also be increased, studying alternative safe-havens that could be even better than the US dollar. Campbell, Medeiros & Viceira (2010), for instance, show that the Japanese yen and the Swiss franc tend to work as good safe-haven currencies as well. Rather than using fixed allocation weights, a systematic strategy that tilts allocation between equities and foreign exchange in pre-determined circumstances could also add further value to our framework.

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APPENDIX

APPENDIX A – DATA SUMMARY

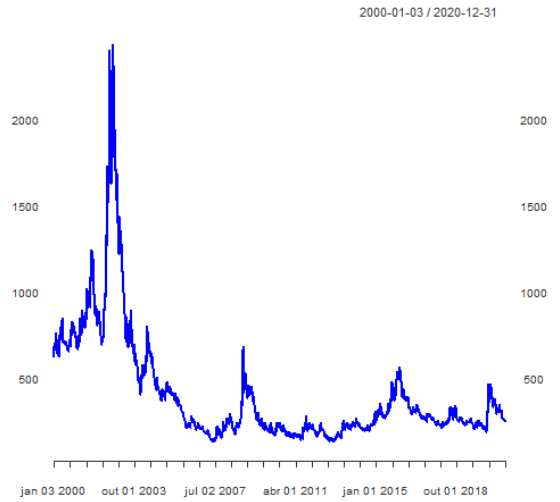
Table 28 – Bloomberg terminal tickers, data treatment and analysis start date

BLOOMBERG TICKER	DESCRIPTION	TREATMENT	ANALYSIS START DATE
SPBDU1BT Index	Ten year treasury total return	No treatment	
IBOV Index	Brazilian (IBOVESPA) stock market	Total return field	03/jan/2000
USDBRLTL CMPN Curncy	Total return of long-dollar against Brazilian real	No treatment	
JPSSEMBR Index	Brazil EMBI+ spread	No treatment	
JPEMBZ Index	Brazil EMBI+ total return	No treatment	
BZDIOVRA Index	Brazil overnight interest rate	No treatment	
MEXBOL Index	Mexican (MEXBOL) stock market	Total return field	03/jan/2000
USDMXNTL CMPN Curncy	Total return of long-dollar against Mexican peso	No treatment	
JPSSEMME Index	Mexico EMBI+ spread	No treatment	
JPEMMX Index	Mexico EMBI+ total return	No treatment	
MXBRBA Index	Mexico overnight interest rate	No treatment	
IPSA Index	Chile (IPSA) stock market	Total return field	24/jan/2003
USDCLPTL CMPN Curncy	Total return of long-dollar against Chilean peso	No treatment	
CHILE CDS USD SR 5Y D14 Corp	Chilean five-year sovereign CDS spread	No treatment	
CHOVCHOV Index	Chile overnight interest rate	No treatment	
IMOEX Index	Russian (MOEX) stock market	Total return field	08/jan/2000
USDRUBTL Curncy	Total return of long-dollar against Russian ruble	No treatment	
JPSSEMRU Index	Russia EMBI+ spread	No treatment	
JPEMRUS Index	Russia EMBI+ total return	No treatment	
RUONIA Index	The weighted average interest rate on overnight interbank ruble loans.	From 2000 to 2010 only the MIACR is available. From February 2010 to the end of 2016 we use the average of RUONIA and MIACR. From 2017 onwards we use Ruonia. This treatment is based solely on data availability in the Bloomberg terminal.	
MMIBRON Index	The weighted average interest rate on overnight interbank ruble loans on the Moscow market.		
JALSH Index	South African (JALSH) stock market	Total return field	30/abr/2002
USDZARTL CMPN Curncy	Total return of long-dollar against South African rand	No treatment	
JPSSEMSA Index	South Africa EMBI+ spread	No treatment	
JPEMZA Index	South Africa EMBI+ total return	No treatment	
SARPRT Index	South Africa overnight interest rate	No treatment	
COLCAP Index	Colombian (COLCAP) stock market	Total return field	15/jul/2002
USDCOPTL CMPN Curncy	Total return of long-dollar against Colombian peso	No treatment	
JPSSEMCO Index	Colombia EMBI+ spread	No treatment	
JPEMCO Index	Colombia EMBI+ total return	No treatment	
CORRRMIN Index	Colombia overnight interest rate	No treatment	
XU100 Index	Turkish (XU100) stock market	Total return field	02/jan/2002
USDTRYTL CMPN Curncy	Total return of long-dollar against Turkish lira	No treatment	
JPSSEMTU Index	Turkey EMBI+ spread	No treatment	
JPEMTU Index	Turkey EMBI+ total return	No treatment	
TUIBON Index	Overnight borrowing rate	The Turkish interest rate used is the average of the borrowing and lending rate	
TUIBTUIB Index	Overnight lending rate		

Figure 17 – Brazil time series of interest

(a) IBOVESPA (Brazil) total return

(b) USDBRL total return



(c) EMBI+ Brazil spread

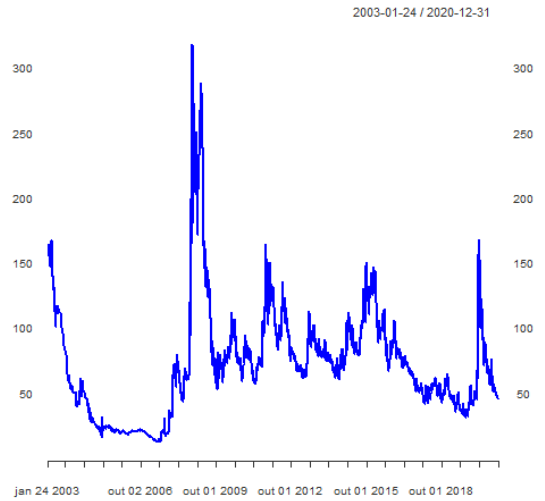
(d) EMBI+ Brazil total return

(e) EMBI+ Brazil spread total return

Figure 18 – Chile time series of interest

(a) IPSA (Chile) total return

(b) USDCLP total return

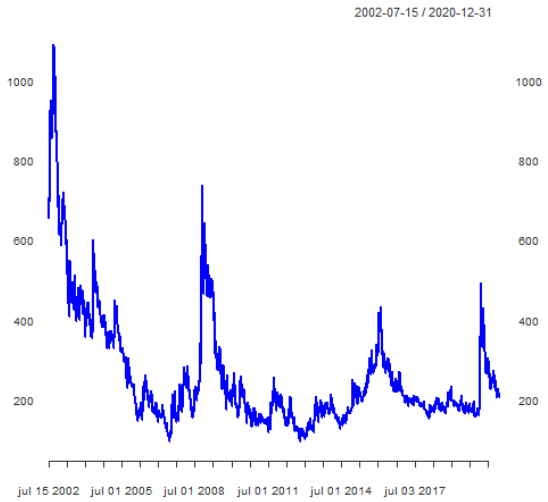


(c) 5-Year CDS spread Chile

Figure 19 – Colombia time series of interest

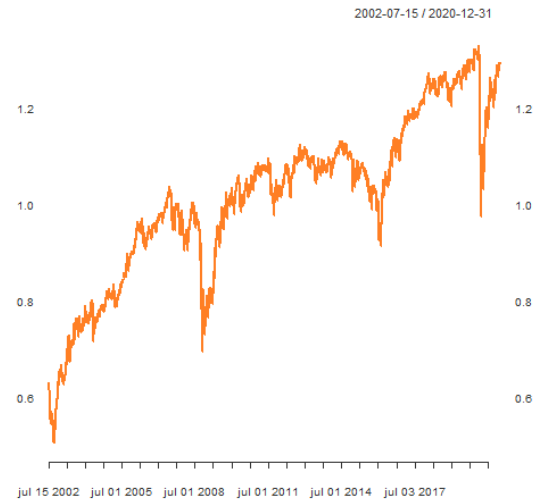
(a) COLCAP (Colombia) total return

(b) USDCOP total return



(c) EMBI+ Colombia spread

(d) EMBI+ Colombia total return

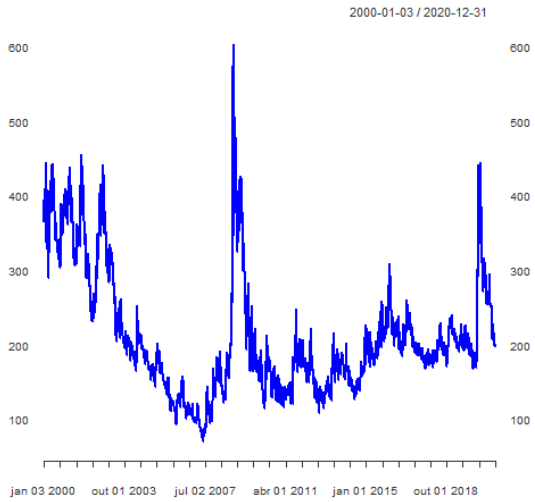


(e) EMBI+ Colombia spread total return

Figure 20 – Mexico time series of interest

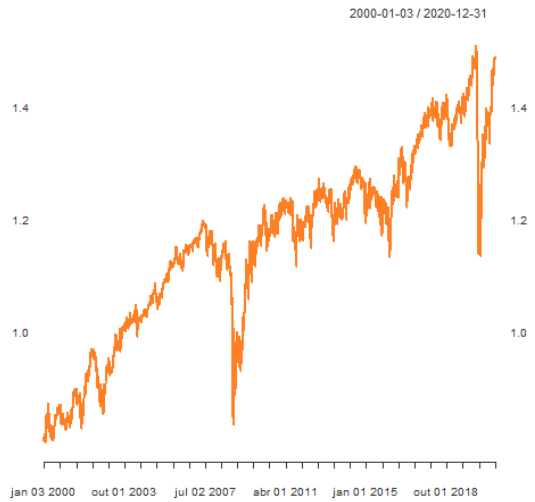
(a) MEXBOL (Mexico) total return

(b) USDMXN total return



(c) EMBI+ Mexico spread

(d) EMBI+ Mexico total return

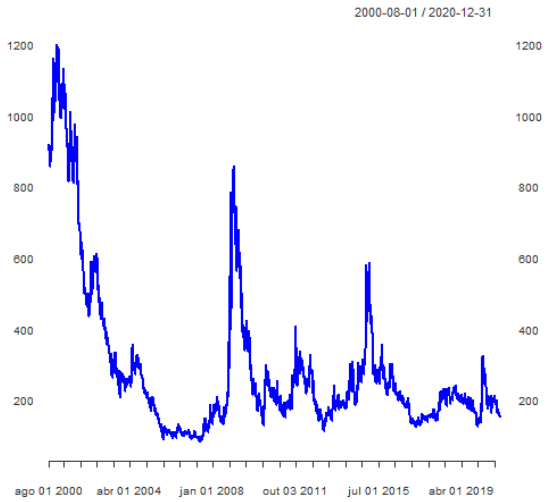


(e) EMBI+ Mexico spread total return

Figure 21 – Russia time series of interest

(a) MOEX (Russia) total return

(b) USDRUB total return



(c) EMBI+ Russia spreads

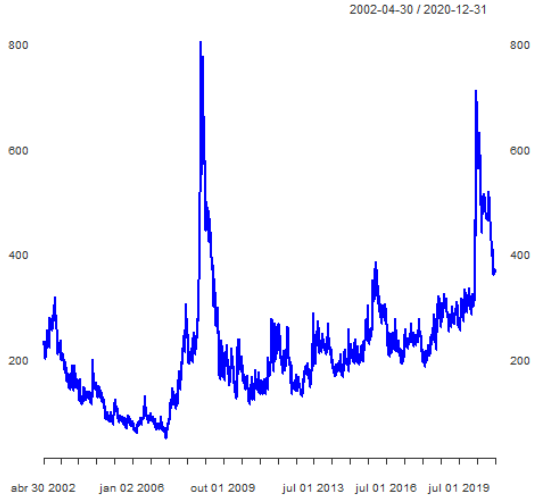
(d) EMBI+ Russia total return

(e) EMBI+ Russia spread total return

Figure 22 – South Africa time series of interest

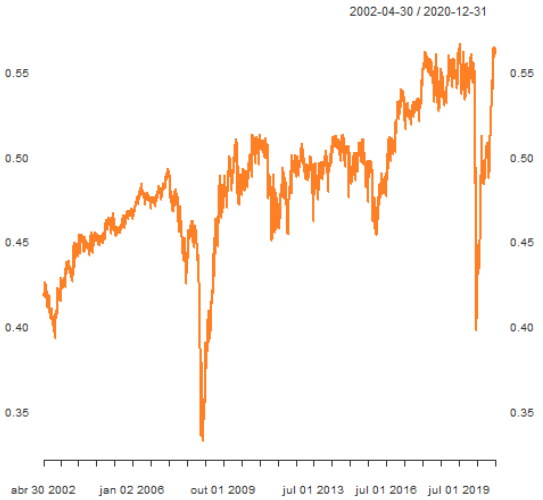
(a) JALSH (South Africa) total return

(b) USDZAR total return



(c) EMBI+ South Africa spread

(d) EMBI+ South Africa total return

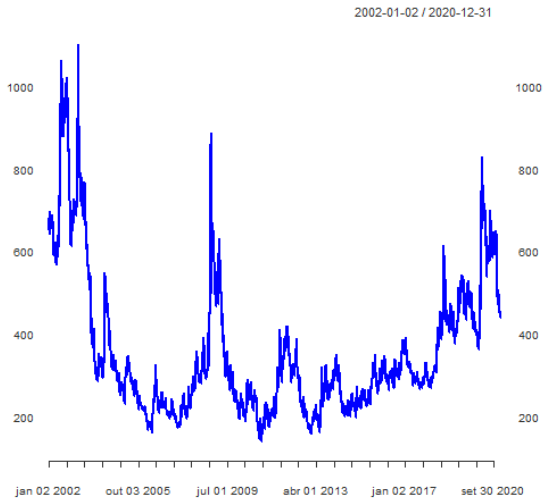


(e) EMBI+ South Africa spread total return

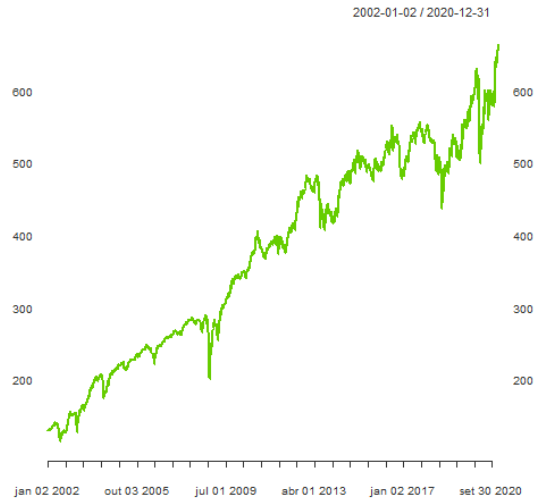
Figure 23 – Turkey time series of interest

(a) XU100 (Turkey) total return

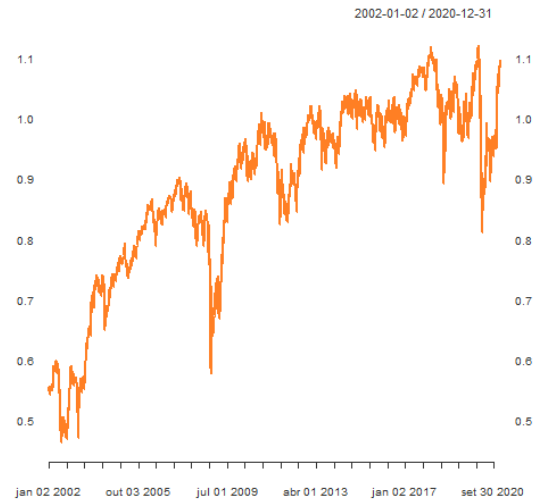
(b) USDTRY total return



(c) EMBI+ Turkey spread



(d) EMBI+ Turkey total return



(e) EMBI+ Turkey spread total return

APPENDIX B – KEYS FOR CHAPTER 5 TABLES AND FIGURES

Chapter 5 details distribution statistics and displays line graphs for our suggested investment strategy over our full sample and for two alternative sub-periods (2000 to 2010 and 2011 to 2020). For the sake of conciseness we use short legends and column names in the graphs and tables displayed in chapter 5. These are explained in this Appendix. We also provide definitions for all portfolio statistics that we present.

B.1 Chapter 5 Table and Graph Keys

Table 29 – Chapter 5 table column names

COLUMN NAME	DESCRIPTION
STOCKS/FX	50/50 long-stocks long-dolar strategy
STOCKS/EMBI+	50/50 long-stocks short EMBI+ spread strategy
STOCKS	Long local stocks position

Table 30 – Chapter 5 graph legend labels

LEGEND	DESCRIPTION
STRAT_FX	50/50 long-stocks long-dolar strategy
STRAT_EMBI	50/50 long-stocks short EMBI+ spread strategy
STOCKS	Long local stocks position
FX	Long US dollar position against local currency
EMBI+ Local	Long EMBI+ position in local currency
RF_RATE	Risk-free rate

B.2 Portfolio Statistics Formulas and Definitions

Return: The average geometric return of a time-series,

$$\overline{x} = \exp\left(\sum_{n=1}^{N} \frac{\ln(x_n + 1)}{N}\right)$$

Where the x_n are the percentage returns.

Excess Return: The average geometric return of a risk-prone strategy minus the average geometric return of a risk-free rate over an equal time-period. In this dissertation, for each country we use its respective local risk-free rate.

Volatility: The geometric standard deviation of a time-series,

$$\hat{\sigma}_x = \exp\left(\sqrt{\frac{1}{n-1}\sum_{n=1}^{N}\left(\frac{\ln(x_n + 1)}{1 + \overline{x}}\right)^2}\right)$$

Where the x_n are the percentage returns.

Beta: The sensitivity of asset returns to market returns,

$$\hat{\beta}_x = \frac{Cov(R_x, R_m)}{Var(R_m)}$$

Risk Reward: The average geometric return of a time-series divided by its geometric standard deviation,

$$RR_x = \frac{\overline{x}}{\sigma_x}$$

Sharpe Ratio: The average geometric excess return of a time-series divided by its geometric standard deviation,

$$Sharpe_x = \frac{\overline{x} - \overline{x}_{rf}}{\sigma_x}$$

Sortino Ratio: The average geometric excess return of a time-series divided by the geometric standard deviation of negative returns only,

$$Sortino_x = \frac{\overline{x} - \overline{x}_{rf}}{\sigma_{x<0}}$$

Treynor Ratio: The average geometric excess return of a time-series divided by its *beta* to the market,

$$Treynor_x = \frac{\overline{x} - \overline{x}_{rf}}{\beta_x}$$

Conditional/Shortfall 95% Risk-Reward Ratio: The average geometric return of a time-series divided by the absolute value of its 95% expected shortfall,

$$CRR_x = \frac{\overline{x}}{|ES_{5\%}(X)|}$$

Conditional/Shortfall 95% Sharpe Ratio: The average geometric excess return of a time-series divided by the absolute value of its 95% expected shortfall,

$$CSharpe_x = \frac{\overline{x} - \overline{x}_{rf}}{|ES_{5\%}(X)|}$$

Skewness: Skewness measures the asymmetry of the return distribution,

$$\hat{\eta}_3 = \frac{\hat{\mu}_3}{\sigma^3} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^3}{[\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2]^{3/2}}$$

Kurtosis: Kurtosis measures the two-sided "fatness"of tails in the return distribution,

$$\hat{\eta}_4 = \frac{\hat{\mu}_4}{\sigma^4} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^4}{[\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2]^2}$$

95% Expected Shortfall: The arithmetic average of returns falling in the lower 5% quantile of returns,

$$\hat{ES_{5\%}}(X) = \mathbb{E}\left[X | X \leq Var_{5\%}(X)\right]$$

Where $Var_{5\%}$ is the Value at Risk for the 5% cut-off.

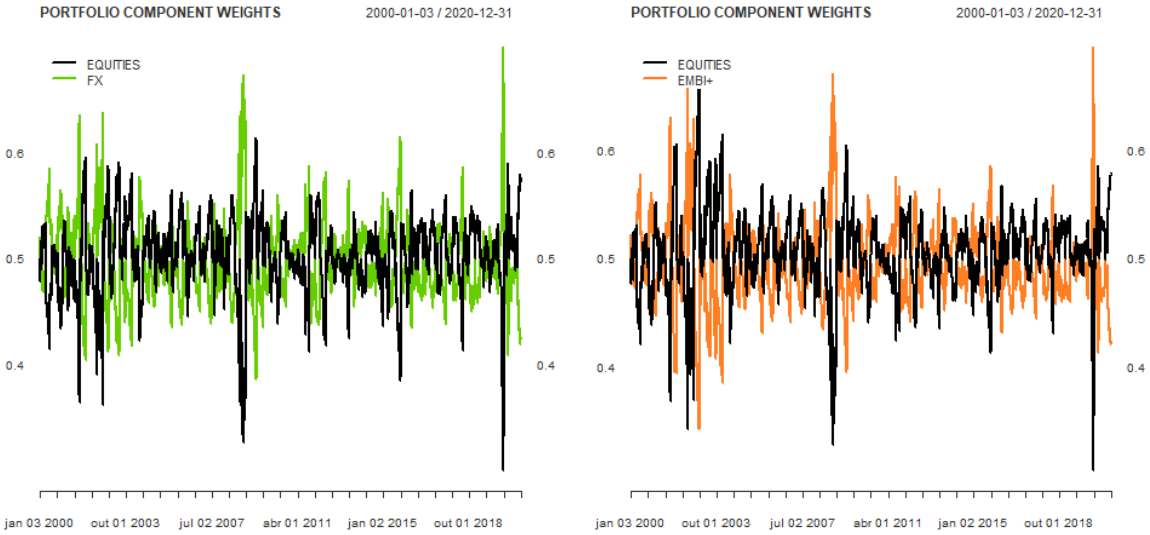
Maximum Drawdown: The drawdown is a measure of decline from a historical peak in the total return series. The maximum dradown is the maximum loss from a historical peak in the series. The maximum drawdown up to time T for a given time-series is calculated by,

$$MDD_t = \max_{\tau \epsilon (0,T)} \left[\max_{t \epsilon (0,\tau)} \left(X(t) - X(\tau) \right) \right]$$

APPENDIX C – PORTFOLIO COMPONENT WEIGHTS

In this appendix we present the moving portfolio weights of strategies analyzed in chapter 5.

Figure 24 – Brazil portfolio weights



(a) Equities/FX strategy

(b) Equities/EMBI+ Spread Strategy

Figure 25 – Chile portfolio weights

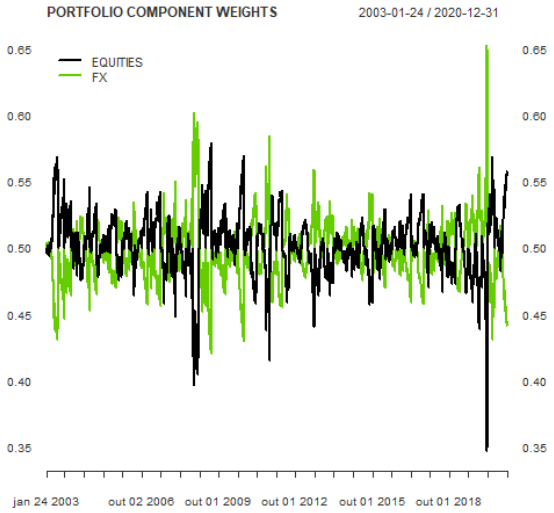
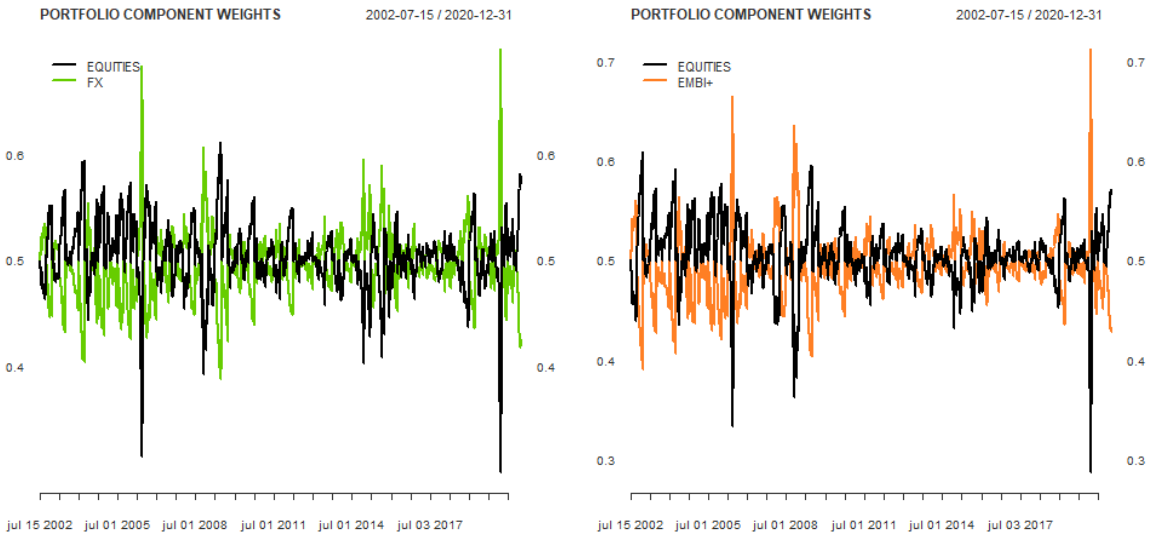
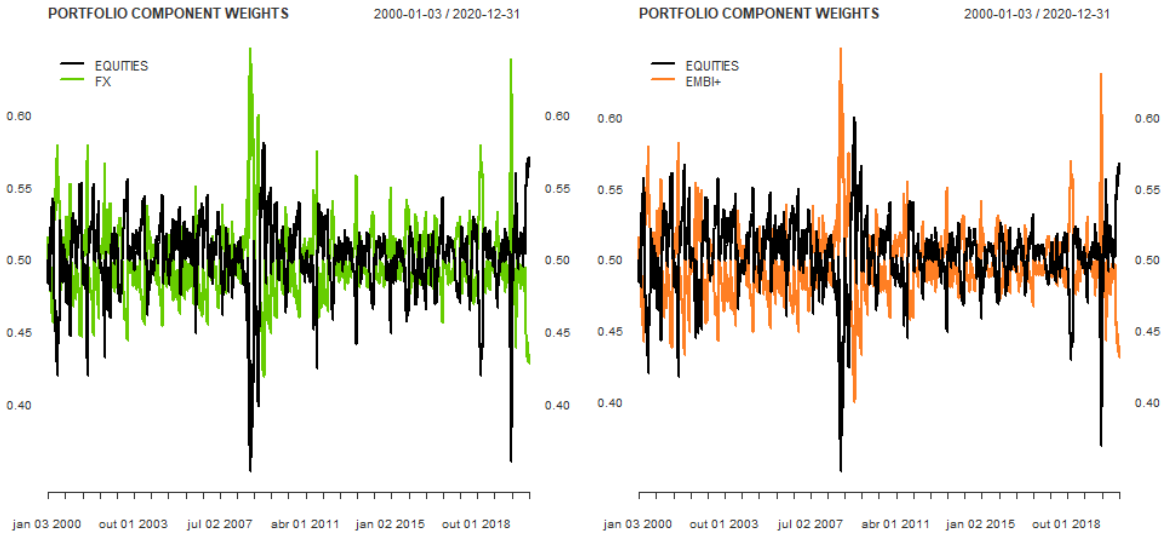


Figure 26 – Colombia portfolio weights



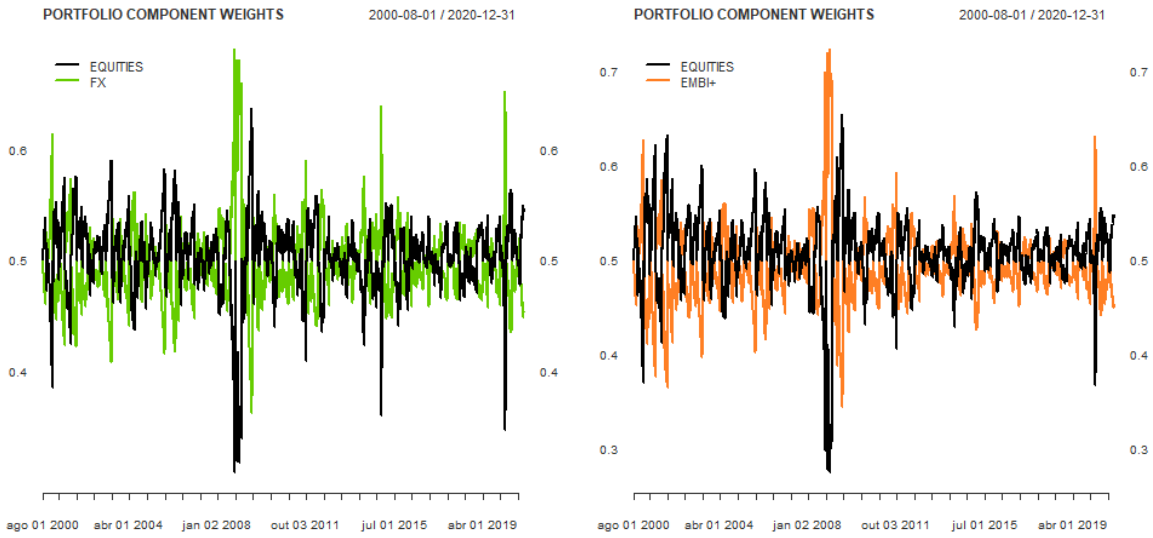
(a) Equities/FX strategy (b) Equities/EMBI+ Spread Strategy

Figure 27 – Mexico portfolio weights



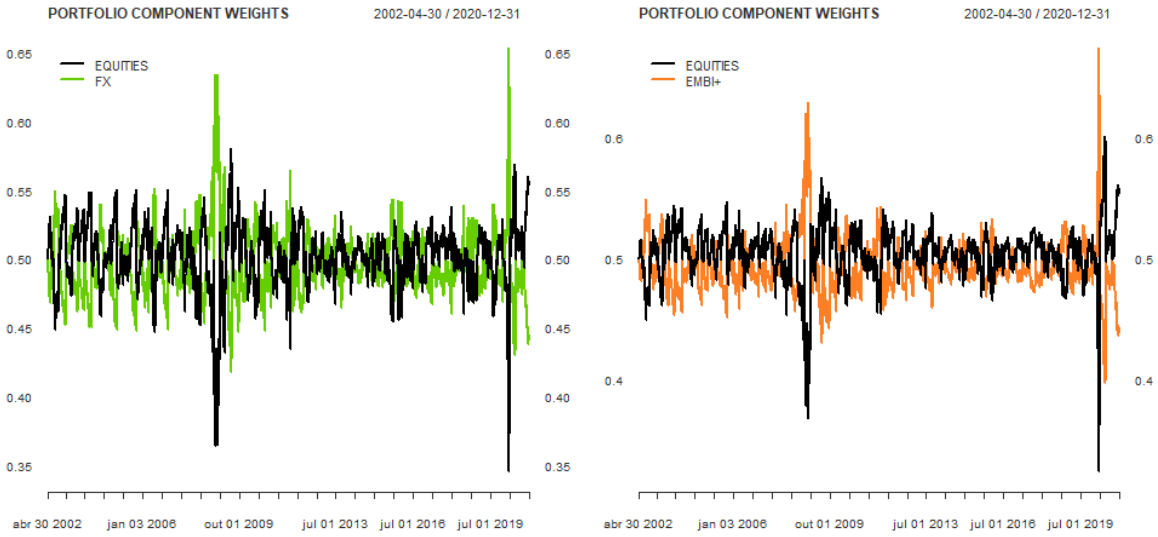
(a) Equities/FX strategy (b) Equities/EMBI+ Spread Strategy

Figure 28 – Russia portfolio weights



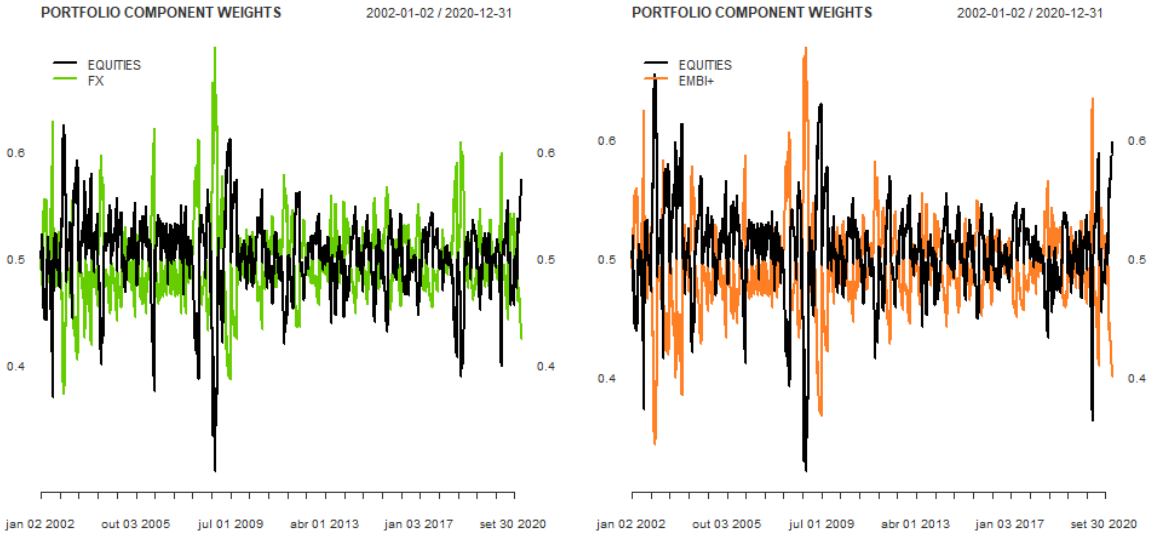
(a) Equities/FX strategy (b) Equities/EMBI+ Spread Strategy

Figure 29 – South Africa portfolio weights



(a) Equities/FX strategy (b) Equities/EMBI+ Spread Strategy

Figure 30 – Turkey portfolio weights



(a) Equities/FX strategy

(b) Equities/EMBI+ Spread Strategy

APPENDIX D – PORTFOLIO OPTIMIZATION RESULTS

In this Appendix we present the full optimization results analyzed in chapter 7.

Table 31 – Brazil: portfolio Sharpe ratio optimization results

	EQUITY	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	10.52	-1.19	12.10	0.87	-0.10	-1.64	-19.73
RF: 0%	1.00	0.00	0.00	9.37	-2.33	28.97	0.32	-0.08	-4.04	-59.96
RF: 10%	0.90	0.00	0.10	9.97	-1.73	25.85	0.39	-0.07	-3.61	-55.10
RF: 20%	0.80	0.00	0.20	10.49	-1.22	22.80	0.46	-0.05	-3.18	-49.91
RF: 30%	0.70	0.00	0.30	10.91	-0.80	19.80	0.55	-0.04	-2.76	-44.38
RF: 40%	0.60	0.00	0.40	11.26	-0.45	16.83	0.67	-0.03	-2.34	-38.49
RF: 50%	0.50	0.00	0.50	11.52	-0.19	13.89	0.83	-0.01	-1.92	-32.22
RF: 60%	0.40	0.00	0.60	11.70	-0.01	11.01	1.06	-0.00	-1.52	-25.57
RF: 70%	0.30	0.00	0.70	11.81	0.10	8.19	1.44	0.01	-1.12	-18.50
RF: 80%	0.20	0.00	0.80	11.85	0.14	5.43	2.18	0.03	-0.72	-11.05
RF: 90%	0.10	0.00	0.90	11.82	0.11	2.71	4.36	0.04	-0.34	-4.22

Table 32 – Brazil: portfolio risk-reward ratio optimization results

	EQUITY	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	10.52	-1.19	12.10	0.87	-0.10	-1.64	-19.73
RF: 0%	0.39	0.61	0.00	10.08	-1.63	10.69	0.94	-0.15	-1.44	-17.36
RF: 10%	0.35	0.55	0.10	10.24	-1.46	9.62	1.07	-0.15	-1.29	-14.36
RF: 20%	0.31	0.49	0.20	10.42	-1.29	8.54	1.22	-0.15	-1.14	-11.29
RF: 30%	0.27	0.43	0.30	10.61	-1.10	7.47	1.42	-0.15	-0.99	-8.80
RF: 40%	0.23	0.37	0.40	10.81	-0.90	6.39	1.69	-0.14	-0.84	-7.06
RF: 50%	0.19	0.31	0.50	11.00	-0.71	5.32	2.07	-0.13	-0.69	-5.54
RF: 60%	0.15	0.25	0.60	11.17	-0.53	4.25	2.63	-0.13	-0.55	-4.01
RF: 70%	0.11	0.19	0.70	11.33	-0.38	3.19	3.55	-0.12	-0.40	-2.76
RF: 80%	0.07	0.13	0.80	11.47	-0.24	2.14	5.37	-0.11	-0.25	-1.82
RF: 90%	0.04	0.06	0.90	11.60	-0.11	1.09	10.62	-0.10	-0.10	-0.86

Table 33 – Chile: portfolio Sharpe ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	5.43	2.03	8.39	0.65	0.24	-1.19	-18.36
RF: 0%	0.72	0.28	0.00	6.65	3.26	11.31	0.59	0.29	-1.64	-29.94
RF: 10%	0.66	0.24	0.10	6.45	3.05	10.35	0.62	0.30	-1.50	-27.75
RF: 20%	0.60	0.20	0.20	6.23	2.83	9.38	0.66	0.30	-1.36	-25.40
RF: 30%	0.53	0.17	0.30	5.99	2.59	8.39	0.71	0.31	-1.22	-22.89
RF: 40%	0.47	0.13	0.40	5.73	2.33	7.36	0.78	0.32	-1.07	-20.18
RF: 50%	0.40	0.10	0.50	5.44	2.05	6.31	0.86	0.32	-0.92	-17.22
RF: 60%	0.33	0.07	0.60	5.13	1.73	5.22	0.98	0.33	-0.76	-14.11
RF: 70%	0.26	0.04	0.70	4.78	1.39	4.08	1.17	0.34	-0.59	-11.05
RF: 80%	0.18	0.02	0.80	4.39	1.00	2.87	1.53	0.35	-0.41	-7.77
RF: 90%	0.10	0.00	0.90	3.95	0.56	1.55	2.55	0.36	-0.22	-4.07

Table 34 – Chile: portfolio risk-reward ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	5.43	2.03	8.39	0.65	0.24	-1.19	-18.36
RF: 0%	0.51	0.49	0.00	5.51	2.12	8.51	0.65	0.25	-1.21	-18.69
RF: 10%	0.45	0.45	0.10	5.28	1.89	7.59	0.70	0.25	-1.08	-16.45
RF: 20%	0.40	0.40	0.20	5.05	1.65	6.67	0.76	0.25	-0.94	-14.18
RF: 30%	0.34	0.36	0.30	4.80	1.41	5.75	0.83	0.24	-0.81	-11.89
RF: 40%	0.28	0.32	0.40	4.56	1.17	4.86	0.94	0.24	-0.68	-9.59
RF: 50%	0.23	0.27	0.50	4.32	0.93	3.99	1.08	0.23	-0.56	-7.39
RF: 60%	0.17	0.23	0.60	4.10	0.70	3.14	1.30	0.22	-0.43	-5.44
RF: 70%	0.12	0.18	0.70	3.89	0.49	2.33	1.67	0.21	-0.32	-3.57
RF: 80%	0.08	0.12	0.80	3.70	0.30	1.54	2.41	0.20	-0.20	-2.03
RF: 90%	0.04	0.06	0.90	3.53	0.14	0.77	4.60	0.18	-0.10	-0.95

Table 35 – Colombia: portfolio Sharpe ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	10.73	5.37	9.53	1.13	0.56	-1.34	-18.89
RF: 0%	0.59	0.41	0.00	11.69	6.32	10.86	1.08	0.58	-1.56	-24.15
RF: 10%	0.54	0.36	0.10	11.20	5.84	9.83	1.14	0.59	-1.41	-21.96
RF: 20%	0.49	0.31	0.20	10.70	5.33	8.84	1.21	0.60	-1.27	-19.84
RF: 30%	0.43	0.27	0.30	10.18	4.82	7.87	1.29	0.61	-1.13	-17.83
RF: 40%	0.38	0.22	0.40	9.66	4.30	6.94	1.39	0.62	-1.00	-15.87
RF: 50%	0.33	0.17	0.50	9.12	3.75	5.99	1.52	0.63	-0.87	-13.82
RF: 60%	0.28	0.12	0.60	8.53	3.16	4.98	1.71	0.63	-0.72	-11.54
RF: 70%	0.22	0.08	0.70	7.87	2.51	3.90	2.02	0.64	-0.56	-8.97
RF: 80%	0.15	0.05	0.80	7.14	1.78	2.72	2.63	0.65	-0.39	-6.09
RF: 90%	0.08	0.02	0.90	6.32	0.96	1.44	4.39	0.67	-0.20	-2.96

Table 36 – Colombia: portfolio risk-reward ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	10.73	5.37	9.53	1.13	0.56	-1.34	-18.89
RF: 0%	0.48	0.52	0.00	10.46	5.10	9.27	1.13	0.55	-1.30	-17.51
RF: 10%	0.42	0.48	0.10	9.98	4.62	8.30	1.20	0.56	-1.16	-15.46
RF: 20%	0.37	0.43	0.20	9.47	4.11	7.33	1.29	0.56	-1.02	-13.43
RF: 30%	0.32	0.38	0.30	8.92	3.56	6.37	1.40	0.56	-0.89	-11.43
RF: 40%	0.27	0.33	0.40	8.35	2.98	5.41	1.54	0.55	-0.75	-9.45
RF: 50%	0.22	0.28	0.50	7.76	2.40	4.46	1.74	0.54	-0.62	-7.50
RF: 60%	0.17	0.23	0.60	7.20	1.83	3.53	2.04	0.52	-0.48	-5.59
RF: 70%	0.12	0.18	0.70	6.66	1.30	2.62	2.54	0.50	-0.35	-3.75
RF: 80%	0.08	0.12	0.80	6.17	0.81	1.73	3.57	0.47	-0.22	-2.03
RF: 90%	0.04	0.06	0.90	5.73	0.37	0.86	6.64	0.43	-0.10	-0.69

Table 37 – Mexico: portfolio Sharpe ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	9.01	2.54	9.44	0.95	0.27	-1.30	-16.77
RF: 0%	0.57	0.43	0.00	9.37	2.89	10.54	0.89	0.27	-1.48	-20.33
RF: 10%	0.52	0.38	0.10	9.14	2.67	9.61	0.95	0.28	-1.35	-18.23
RF: 20%	0.46	0.34	0.20	8.90	2.43	8.62	1.03	0.28	-1.20	-15.61
RF: 30%	0.41	0.29	0.30	8.65	2.18	7.56	1.14	0.29	-1.05	-13.19
RF: 40%	0.35	0.25	0.40	8.38	1.91	6.47	1.30	0.30	-0.89	-10.53
RF: 50%	0.30	0.20	0.50	8.10	1.63	5.37	1.51	0.30	-0.74	-8.46
RF: 60%	0.24	0.16	0.60	7.81	1.34	4.29	1.82	0.31	-0.59	-6.36
RF: 70%	0.18	0.12	0.70	7.50	1.03	3.23	2.32	0.32	-0.43	-4.16
RF: 80%	0.12	0.08	0.80	7.17	0.70	2.17	3.30	0.32	-0.28	-2.22
RF: 90%	0.06	0.04	0.90	6.84	0.37	1.12	6.12	0.33	-0.13	-0.85

Table 38 – Mexico: portfolio risk-reward ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	9.01	2.54	9.44	0.95	0.27	-1.30	-16.77
RF: 0%	0.40	0.60	0.00	8.43	1.96	8.41	1.00	0.23	-1.13	-11.34
RF: 10%	0.35	0.55	0.10	8.22	1.75	7.55	1.09	0.23	-1.01	-9.61
RF: 20%	0.31	0.49	0.20	8.02	1.55	6.70	1.20	0.23	-0.89	-8.19
RF: 30%	0.27	0.43	0.30	7.83	1.36	5.84	1.34	0.23	-0.77	-6.55
RF: 40%	0.23	0.37	0.40	7.66	1.18	4.99	1.54	0.24	-0.66	-5.37
RF: 50%	0.19	0.31	0.50	7.47	1.00	4.14	1.81	0.24	-0.54	-4.23
RF: 60%	0.15	0.25	0.60	7.29	0.81	3.30	2.21	0.25	-0.43	-3.07
RF: 70%	0.11	0.19	0.70	7.09	0.62	2.47	2.87	0.25	-0.31	-1.95
RF: 80%	0.07	0.13	0.80	6.88	0.41	1.65	4.17	0.25	-0.20	-1.25
RF: 90%	0.04	0.06	0.90	6.68	0.21	0.84	7.98	0.25	-0.09	-0.53

Table 39 – Russia: portfolio Sharpe ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	13.67	7.28	15.04	0.91	0.48	-2.18	-37.94
RF: 0%	0.47	0.53	0.00	13.34	6.95	14.31	0.93	0.49	-2.05	-35.08
RF: 10%	0.43	0.47	0.10	12.79	6.41	13.05	0.98	0.49	-1.88	-32.39
RF: 20%	0.39	0.41	0.20	12.24	5.85	11.77	1.04	0.50	-1.70	-29.62
RF: 30%	0.35	0.35	0.30	11.67	5.28	10.48	1.11	0.50	-1.51	-26.77
RF: 40%	0.30	0.30	0.40	11.08	4.69	9.17	1.21	0.51	-1.32	-23.78
RF: 50%	0.26	0.24	0.50	10.45	4.06	7.81	1.34	0.52	-1.13	-20.53
RF: 60%	0.22	0.18	0.60	9.78	3.39	6.40	1.53	0.53	-0.92	-16.92
RF: 70%	0.17	0.13	0.70	9.04	2.65	4.93	1.83	0.54	-0.71	-12.88
RF: 80%	0.12	0.08	0.80	8.23	1.85	3.39	2.43	0.54	-0.48	-8.36
RF: 90%	0.06	0.04	0.90	7.36	0.97	1.78	4.15	0.55	-0.24	-3.34

Table 40 – Russia: portfolio risk-reward ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	13.67	7.28	15.04	0.91	0.48	-2.18	-37.94
RF: 0%	0.34	0.66	0.00	11.83	5.45	12.03	0.98	0.45	-1.61	-22.98
RF: 10%	0.30	0.60	0.10	11.31	4.92	10.85	1.04	0.45	-1.45	-20.18
RF: 20%	0.26	0.54	0.20	10.78	4.39	9.66	1.12	0.45	-1.28	-17.66
RF: 30%	0.23	0.47	0.30	10.25	3.86	8.48	1.21	0.46	-1.11	-16.08
RF: 40%	0.19	0.41	0.40	9.71	3.32	7.29	1.33	0.45	-0.95	-14.36
RF: 50%	0.16	0.34	0.50	9.15	2.76	6.10	1.50	0.45	-0.78	-12.49
RF: 60%	0.12	0.28	0.60	8.59	2.20	4.90	1.75	0.45	-0.61	-10.45
RF: 70%	0.09	0.21	0.70	8.02	1.63	3.70	2.17	0.44	-0.45	-8.21
RF: 80%	0.06	0.14	0.80	7.46	1.07	2.49	3.00	0.43	-0.29	-5.69
RF: 90%	0.03	0.07	0.90	6.91	0.52	1.27	5.44	0.41	-0.13	-2.84

Table 41 – South Africa: portfolio Sharpe ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	8.70	1.62	11.96	0.73	0.14	-1.56	-31.29
RF: 0%	0.90	0.10	0.00	11.63	4.55	17.02	0.68	0.27	-2.43	-38.44
RF: 10%	0.82	0.08	0.10	11.35	4.27	15.61	0.73	0.27	-2.24	-35.83
RF: 20%	0.74	0.06	0.20	11.03	3.95	14.12	0.78	0.28	-2.03	-32.85
RF: 30%	0.66	0.04	0.30	10.68	3.60	12.52	0.85	0.29	-1.80	-29.40
RF: 40%	0.57	0.03	0.40	10.29	3.21	10.83	0.95	0.30	-1.56	-25.46
RF: 50%	0.48	0.02	0.50	9.88	2.80	9.10	1.09	0.31	-1.31	-21.19
RF: 60%	0.39	0.01	0.60	9.44	2.36	7.39	1.28	0.32	-1.06	-16.77
RF: 70%	0.30	0.00	0.70	8.94	1.87	5.63	1.59	0.33	-0.80	-11.93
RF: 80%	0.20	0.00	0.80	8.36	1.28	3.74	2.24	0.34	-0.52	-6.44
RF: 90%	0.10	0.00	0.90	7.74	0.66	1.86	4.16	0.35	-0.25	-2.97

Table 42 – South Africa: portfolio risk-reward ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	8.70	1.62	11.96	0.73	0.14	-1.56	-31.29
RF: 0%	0.64	0.36	0.00	9.86	2.78	12.73	0.77	0.22	-1.71	-32.86
RF: 10%	0.57	0.33	0.10	9.56	2.48	11.39	0.84	0.22	-1.53	-29.47
RF: 20%	0.50	0.30	0.20	9.25	2.17	10.04	0.92	0.22	-1.34	-25.61
RF: 30%	0.43	0.27	0.30	8.96	1.88	8.71	1.03	0.22	-1.15	-21.20
RF: 40%	0.36	0.24	0.40	8.69	1.61	7.40	1.17	0.22	-0.97	-16.34
RF: 50%	0.29	0.21	0.50	8.42	1.34	6.11	1.38	0.22	-0.80	-11.32
RF: 60%	0.23	0.17	0.60	8.14	1.06	4.85	1.68	0.22	-0.62	-7.16
RF: 70%	0.17	0.13	0.70	7.86	0.78	3.61	2.18	0.22	-0.46	-4.29
RF: 80%	0.11	0.09	0.80	7.59	0.51	2.40	3.17	0.21	-0.29	-2.02
RF: 90%	0.05	0.05	0.90	7.32	0.25	1.20	6.12	0.20	-0.13	-0.94

Table 43 – Turkey: portfolio Sharpe ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	14.51	-0.01	12.86	1.13	-0.00	-1.79	-20.12
RF: 0%	0.76	0.24	0.00	15.15	0.63	19.94	0.76	0.03	-2.86	-41.97
RF: 10%	0.71	0.19	0.10	15.19	0.66	19.13	0.79	0.03	-2.75	-40.47
RF: 20%	0.65	0.15	0.20	15.25	0.73	17.58	0.87	0.04	-2.53	-36.89
RF: 30%	0.56	0.14	0.30	15.34	0.82	15.06	1.02	0.05	-2.15	-30.25
RF: 40%	0.46	0.14	0.40	15.43	0.91	12.19	1.27	0.07	-1.72	-22.04
RF: 50%	0.38	0.12	0.50	15.50	0.98	9.81	1.58	0.10	-1.36	-15.00
RF: 60%	0.30	0.10	0.60	15.52	0.99	7.90	1.96	0.13	-1.08	-10.66
RF: 70%	0.24	0.06	0.70	15.45	0.93	6.20	2.49	0.15	-0.84	-7.79
RF: 80%	0.17	0.03	0.80	15.29	0.77	4.53	3.37	0.17	-0.59	-5.03
RF: 90%	0.10	0.00	0.90	15.04	0.52	2.81	5.35	0.19	-0.34	-2.50

Table 44 – Turkey: portfolio risk-reward ratio optimization results

	STOCK	FX	RF	RET	EXCESS RET	VOL	RR	SHARPE	CVAR 95%	MAX DD
ORIGINAL	0.50	0.50	0.00	14.51	-0.01	12.86	1.13	-0.00	-1.79	-20.12
RF: 0%	0.35	0.65	0.00	13.70	-0.82	10.77	1.27	-0.08	-1.44	-17.74
RF: 10%	0.31	0.59	0.10	13.73	-0.79	9.72	1.41	-0.08	-1.29	-15.09
RF: 20%	0.27	0.53	0.20	13.83	-0.69	8.66	1.60	-0.08	-1.14	-13.02
RF: 30%	0.24	0.46	0.30	14.00	-0.52	7.58	1.85	-0.07	-0.99	-10.92
RF: 40%	0.20	0.40	0.40	14.21	-0.31	6.49	2.19	-0.05	-0.83	-8.77
RF: 50%	0.17	0.33	0.50	14.39	-0.13	5.41	2.66	-0.02	-0.68	-7.23
RF: 60%	0.13	0.27	0.60	14.52	0.00	4.34	3.35	0.00	-0.53	-5.92
RF: 70%	0.10	0.20	0.70	14.59	0.07	3.28	4.45	0.02	-0.39	-4.53
RF: 80%	0.07	0.13	0.80	14.60	0.08	2.22	6.56	0.04	-0.24	-3.05
RF: 90%	0.03	0.07	0.90	14.57	0.05	1.22	11.97	0.04	-0.09	-1.48